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TRANSACTIONS
OF
THE NEW YORK ACADEMY OF SCIENCES

January 1959

THE NEW YORK ACADEMY OF SCIENCES
(Founded in 1817)

COUNCIL, 1959

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The Sections and the Divisions hold meetings regularly, one evening each month, during the academic year, October to May, inclusive. All meetings are held at the building of The New York Academy of Sciences, 2 East Sixty-third Street, New York 21, New York.

Conferences are also held at irregular intervals at times announced by special programs.

SER II, VOL. 21 *January 1959* NO. 3

TRANSACTIONS
OF
THE NEW YORK ACADEMY OF SCIENCES

Editor in Chief
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Executive Director: EUNICE THOMAS MINER

THE NEW YORK ACADEMY OF SCIENCES

REPORT OF THE ANNUAL MEETING

December 4, 1958

The 141st Annual Meeting of the Academy, for the election of Fellows, the presentation of reports, and the transaction of other business, was held at the Academy Building on the evening of Thursday, December 4, 1958.

The first order of business was devoted to the reports of the Officers and Committees of the Academy.

REPORTS OF OFFICERS AND COMMITTEES

Report of the Treasurer

The fiscal year just passed, the 142nd in the history of the Academy, has seen a continued expansion of its activities and facilities to its greatest potential to date. Although this has been accompanied by some growing pains and problems, it has also brought the realization that the benefits offered by the Academy have developed a desirable growth in the Membership and, with the revision of the Sections and Divisions, opened new opportunities for greater extension of the Academy's services in the years to come.

Foremost of the problems presented has been that which, with the continued rise in operating costs and expenses of meetings and conferences, publication costs, postage and other distribution costs for the latter, and a necessary increase in the number of personnel required to handle this accelerated program, has brought a deficit of $49,723.88 in the operating expenses.

While the Membership has derived the greatest benefit from these increased activities, the income from annual dues amounted to an estimated receipt of $14.50 per Member (based upon a total of 16,000 Members) and the estimated annual expense of carrying each Member was $24.33 as of October 31, 1958.

This latter figure would have been much higher if the staff of the Academy did not maintain a continuing and aggressive action to obtain better results from other sources of income such as sales of publications, use of the building by other organizations, and an active press for the general printing work of the Academy, while at the same time making every effort to improve efficiency and reduce costs in the performance of the Academy's work.

The Council has postponed as long as possible the necessity for increasing the dues of the Annual Active and Sustaining Members, while endeavoring at the same time to increase the benefits to the Members with a healthy expansion in the conferences and publications, in addition to the other privileges that Membership in the Academy offers.

The Academy has added more than 3,000 new Members to its rolls during the past year. It is hoped that, with the increase in dues beginning January 1, 1959, the appreciation of the Membership will be expressed by its continued interest and support of these activities that have contributed so much to science and to the success and growth of the Academy.

Except for the excess of expense over income in the General Funds, applied to general operating activities, all assets of the capital funds show an increase over the totals achieved a year ago.

The gross worth of the Academy, including the total assets of capital and operating funds amounted to $1,241,184.46, an increase of $49,110.36 above the closing figures of $1,192,074.10, the total gross worth for 1957.

Of the capital assets, the Endowment Funds have increased $19,413.39; the Building Fund improved its total by $1,749.07; and the earnings of the Prize Funds increased $295.41. The assets, Accounts Receivable, of the General Funds increased $45,761.98, while the Special Funds, including grants-in-aid decreased in the amount of $18,109.49.

The budget estimate for income was exceeded by the sum of $118,343.87, but due to the major items of expense in the first four accounts of the expenses accrued and covering the activities indicated above, namely the conferences, including the reimbursement of speakers, the publication of the monographs,

postage and materials costs of the distribution to the Members, the actual expenses were $174,183.13 above the budget estimate for disbursements and thus the excess of expenses over income for the year totaled $55,839.26, net.

Despite these statements of the present financial position of the Academy it should be appreciated that the present year has been one of outstanding progress and successful achievement for the Academy in the performance of its stated purposes.

The accounts of the Academy have been examined by the auditors Peat, Marwick, Mitchell & Co. The report of these auditors, which has been approved as of November 25, 1958 by the Finance Committee, as provided by the *Bylaws*, and the financial statements for the year ended October 31, 1958, with comparative figures for the preceding year, appear on the following pages.

Report of the Auditors

PEAT, MARWICK, MITCHELL & CO.
Accountants and Auditors
Seventy Pine Street
New York 5, N. Y.

Accountants' Report

The Finance Committee,
The New York Academy of Sciences:

We have examined the balance sheet of The New York Academy of Sciences as of October 31, 1958 and the related statement of general fund income and expenses and surplus for the year then ended. Our examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

The cash has been confirmed by certificates obtained directly from the depositaries or by count.

We did not confirm the members' dues or the pledges receivable by communication with the respective members or pledgers. We communicated with all debtors on miscellaneous accounts receivable, representing charges for publications, use of building, etc., by mailing the Academy's statements for the month of October accompanied by a request that we be notified of any exceptions. The exceptions reported were explained to our satisfaction.

The inventory of the printing division is stated in accordance with a physical inventory taken and valued by employees of the Academy and certified by the Executive Director as to description, quantities, condition, and valuation. We made tests of the quantities, prices, and computations. The balance sheet does not reflect the books and publications on hand at October 31, 1958, as it is the policy of the Academy to charge publication costs to expense as incurred.

The marketable securities were inspected or confirmed by the custodian and the income therefrom was confirmed by reference to independent sources.

We inspected the deed to the real estate at 2 East 63rd Street, New York, N. Y., contributed to the Academy in 1949. It is carried in the balance sheet at the valuation, $425,000.00, as assessed by the City of New York for real estate tax purposes as of the date of the contribution, plus the cost of improvements. Furniture, fixtures and equipment acquired by the Academy, through purchase or contribution, are not reflected in the assets; the purchases during the year ended October 31, 1958 have been charged to the income of the general fund. In conformity with the practice usually followed by similar organizations. the Academy does not provide for depreciation of the building and improvements.

All liabilities of which we obtained knowledge as a result of our examination have received appropriate recognition.

In our opinion, subject to the foregoing comments, the accompanying balance sheet and statement of general fund income and expenses and surplus present fairly the financial position of The New York Academy of Sciences at October 31, 1958 and the results of its operations for the year then ended, on a basis consistent with that of the preceding year.

PEAT, MARWICK, MITCHELL & CO.

New York, N. Y.
November 21, 1958

THE NEW YORK ACADEMY OF SCIENCES

Comparative Balance Sheet

October 31, 1958 and 1957

ASSETS

	1958	1957
General Fund		
Cash in bank and on hand	$ 1,008.82	6,620.19
Receivables:		
Members' dues	6,275.00	8,535.00
Miscellaneous accounts	85,061.69	21,229.16
Inventory – printing division	7,778.85	17,318.33
Prepaid expenses	1,430.79	2,090.49
	$101,555.15	55,793.17
Endowment Funds		
Cash, deposited with J. R. Williston & Beane	$ 1,667.93	24,511.53
Marketable securities – stated at purchase cost or quoted price at date of contribution (quoted market value at October 31, 1958, $599,597.11)	585,803.34	543,546.35
	$587,471.27	568,057.88
Building Fund		
Cash in bank	$ 203.23	1,026.69
Receivables – pledges	350.00	1,370.00
Marketable securities – stated at purchase cost or quoted price at date of contribution (quoted market value at October 31, 1958, $24,071.25)	21,701.16	18,108.63
Real estate at 2 East 63rd Street, New York, at assessed valuation at date of contribution, and improvements ($27,280.63) at cost	452,280.63	452,280.63
	$474,535.02	472,785.95
Prize Funds		
Cash in bank	$ 3,717.93	3,422.52
Marketable securities – stated at purchase cost or quoted price at date of contribution (quoted market value at October 31, 1958, $40,104.77)	16,546.79	16,546.79
	$ 20,264.72	19,969.31
Special Funds		
Cash in bank	$ 14,208.67	66,891.25
Receivables – miscellaneous accounts	–	8,576.54
Due from general fund	43,149.63	–
	$ 57,358.30	75,467.79

THE NEW YORK ACADEMY OF SCIENCES
Comparative Balance Sheet
October 31, 1958 and 1957

LIABILITIES AND FUNDS

	1958	1957
General Fund		
Liabilities:		
Accounts payable	$ 63,422.13	2,637.62
Mortgage interest accrued, at rate of 4½% a year	1,020.72	1,085.46
Members' dues unearned	39,366.55	35,403.17
Members' dues collected in advance	4,320.00	1,920.00
Due to special funds	43,149.63	–
Fund surplus (deficit), per accompanying statement	(49,723.88)	14,746.92
	$101,555.15	55,793.17
Endowment Funds		
Principal of funds:		
John James Audubon Fund	$ 2,500.00	2,500.00
Nathaniel Lord Britton Fund	30,039.77	30,039.77
Centennial Endowment Fund	7,934.00	7,934.00
Roy Waldo Miner Memorial Publication Fund	7,635.00	7,123.00
John Strong Newberry Fund	1,000.00	1,000.00
George H. Sherwood Memorial Fund	7,000.00	7,000.00
Ralph Winfield Tower Memorial Fund	12,728.00	12,728.00
Thomas Lincoln Casey Fund	213,461.99	213,461.99
John Roger Fund	1,000.00	1,000.00
Capital gains and losses (net) on investment transactions, reserved	304,172.51	285,271.12
	$587,471.27	568,057.88
Building Fund		
Mortgage (balance of principal; original amount, $200,000.00) on real estate (payable $3,750.00 quarterly for principal and interest, and balance due November 1, 1959)	$136,096.76	144,728.30
Principal of fund	338,438.26	328,057.65
	$474,535.02	472,785.95
Prize Funds		
Principal of funds:		
George Frederick Kunz Prize Fund	$ 1,430.39	1,393.68
A. Cressy Morrison Prize Fund	18,834.33	18,575.63
	$ 20,264.72	19,969.31
Special Funds		
Principal of funds:		
Grants-in-aid	$ 56,428.70	68,199.28
Contributions:		
Women's Auxiliary	773.06	573.06
Furniture and fixtures	–	66.15
Auditorium project fund	118.25	115.07
Unexpended investment income of endowment funds	38.29	6,514.23
	$ 57,358.30	75,467.79

THE NEW YORK ACADEMY OF SCIENCES

Comparative Statement of General Fund Income and Expenses and Surplus
Years ended October 31, 1958 and 1957

	1958	*1957*
Income:		
Membership dues	$232,563.97	202,612.51
Sales of publications	266,090.10	259,469.20
Contributions-in-aid	123,928.98	117,267.93
Contributions – use of building facilities	52,225.94	36,722.08
Contributions to general fund	6,783.28	521.00
Income from securities of endowment and building funds	28,717.40	25,214.49
Total Income	$710,309.67	641,807.21
Expenses:		
Publication costs (including salaries and expenses of printing division)	$326,815.08	254,777.59
Distribution of publications	43,145.96	19,633.66
Postage	39,020.41	23,396.57
Conference and meeting expenses	126,829.32	124,529.64
Building operating salaries and expenses	38,911.90	49,693.98
Executive salaries and expenses	39,497.55	30,774.47
Editorial staff – salaries and expenses	51,501.15	49,180.34
Membership expansion – salaries and expenses	26,715.08	18,186.19
Public relations – salaries and expenses	11,935.76	8,402.82
Societies administration	13,573.69	12,725.78
Social security taxes	5,061.46	3,694.25
Interest on mortgage	6,303.72	6,684.31
Accounting salaries and expenses	19,241.26	8,306.73
General office salaries and expenses	17,596.59	14,611.28
Total Expenses	766,148.93	624,597.61
Excess of income over expenses for year	–	17,209.60
Excess of expenses over income for year	(55,839.26)	–
General fund surplus at beginning of year	14,746.92	5,791.11
	(41,092.34)	23,000.71
Deduct contribution from general fund to building fund equivalent to the payments of mortgage principal	8,631.54	8,253.79
General fund surplus (deficit) at end of year	$(49,723.88)	14,746.92

Note: Effective January 1, 1959, as authorized by the Council of the Academy, the dues for general membership have been increased from $15.00 to $25.00 a year.

Report of the Corresponding Secretary

There are, at present, upon the rolls of the Academy, 68 Honorary Life Members The Corresponding Secretary takes this opportunity of presenting the Members of the Academy with an up-to-date list of the Honorary Life Membership Class:

Sven Olof Asplund ..... Gothenburg, Sweden
William Thomas Astbury ..... Leeds, England
Ernst David Bergmann ..... Tel Aviv, Israel
Charles Herbert Best ..... Toronto, Canada
Niels Bjerrum ..... Copenhagen, Valby, Denmark
Niels Bohr ..... Copenhagen, Denmark
Henri Breuil ..... Paris, France
Sir MacFarlane Burnet ..... Victoria, Australia
Adolf F. J. Butenandt ..... Munich, Germany
M. Albert Caquot ..... Paris, France
Alfonso Caso ..... Mexico, D. F., Mexico
Maurice Caullery ..... Paris, France
J. A. Christiansen ..... Copenhagen, Denmark
James Bertram Collip ..... London, Canada
Arthur H. Compton ..... St. Louis, Missouri
Charles Alfred Coulson ..... Oxford, England
Eduardo Cruz-Coke ..... Santiago, Chile
Henrique Da Rocha Lima ..... São Paulo, Brazil
Sir Henry Dale ..... London, England
Thomas Dalling ..... Rome, Italy
Clinton J. Davisson ..... Charlottesville, Virginia
Peter J. W. Debye ..... Ithaca, New York
Albert Defant ..... Innsbruck, Austria
Ulick R. Evans ..... Cambridge, England
Emmanuel Faure-Fremiet ..... Paris, France
Sir Howard Walter Florey ..... Oxford, England
Ross Granville Harrison ..... New Haven, Connecticut
Robert von Heine-Geldern ..... Grub, Austria
Sir David Kennedy Henderson ..... Edinburgh, Scotland
Corneille J. F. Heymans ..... Ghent, Belgium
Sir Cyril Norman Hinshelwood ..... Oxford, England
Bernardo A. Houssay ..... Buenos Aires, Argentina
Julian S. Huxley ..... London, England
Christopher Kelk Ingold ..... London, England
James Tutin Irving ..... Johannesburg, South Africa
Harold Jeffreys ..... Cambridge, England
Peter Kapitza ..... Moscow, U.S.S.R.
Vasant Ramj Khanolkar ..... Bombay, India
Alfred L. Kroeber ..... Berkeley, California
Hugo Rudolph Kruyt ..... The Hague, Holland
K. S. Lashley ..... Orange Park, Florida
Kaj U. Linderstrom-Lang ..... Copenhagen, Valby, Denmark
Robert H. Lowie ..... Berkeley, California
André Lwoff ..... Paris, France
Gregorio Marañón y Posadillo ..... Madrid, Spain
Peter Brian Medawar ..... London, England
Marcus L. E. Oliphant ..... Canberra, Australia
Jean Piaget ..... Geneva, Switzerland
Henri Pieron ..... Paris, France
A. R. Radcliffe-Brown ..... Grahamstown, South Africa
Gaston Leon Ramon ..... Paris, France
Harold Herbert Read ..... London, England
Sir Robert Robinson ..... Great Missenden, Bucks, England
Francis John Worsley Roughton ..... Cambridge, England
John A. M. Runnstrom ..... Stockholm, Sweden
H. Schaefer ..... Heidelberg, Germany
Gerhard Schramm ..... Tübingen, Germany
Adolph H. Schultz ..... Zurich, Switzerland
Wilson Smith ..... London, England
Erik A. Stensio ..... Stockholm, Sweden
Th. Svedberg ..... Uppsala, Sweden
Nicholas H. Swellengrebel ..... Amsterdam, Holland
Albert Szent-Györgyi ..... Woods Hole, Massachusetts
Arne Tiselius ..... Uppsala, Sweden
Felix A. Vening-Meinesz ..... Anersfoort, Holland
Henri René Villat ..... Paris, France
Max von Laue ..... Berlin, Germany
M. S. Watson ..... London, England

Record is made with regret of the death of the following Honorary Life Members:

Vere Gordon Childe, London, England, elected December 6, 1956, died November 1957.
Vladimir A. Obruchev, Moscow, U.S.S.R., elected December 15, 1937, died January 1958.
C. G. Rossby, Stockholm, Sweden, elected December 7, 1949, died August 1957.
Henry Norris Russell, Princeton, New Jersey, elected December 13, 1939, died February 18, 1957.

Report of the Recording Secretary

The Recording Secretary is pleased to report very satisfactory results for the Academy as a whole in the past year.

During 1958, several important steps have been taken by the Council that will increase and intensify the program of activities, strengthen the growth pattern of the Academy, and promise far-reaching benefits for both the Membership and Science in the years ahead.

One of these steps, probably foremost in magnitude of improvement, was a reclassification of the structural organization of the present seven Sections and one Division of the Academy and the addition of six new Divisions resulting in the following revision of the Sections and Divisions. This change will become effective January 1, 1959.

SECTION OF BIOLOGICAL AND MEDICAL SCIENCES
Division of Anthropology
Division of Instrumentation
Division of Mycology
Division of Psychology

SECTION OF CHEMICAL SCIENCES
Division of Biochemistry

SECTION OF GEOLOGICAL SCIENCES
Division of Oceanography and Meteorology

SECTION OF PHYSICAL SCIENCES
Division of Engineering
Division of Mathematics
Division of Nuclear Physics
Division of Space Research

As stated by the Recording Secretary, in the letter to the Membership on October 30, 1958:

"It has long been recognized within the Council and the Membership that, with the growth and development of the Academy, now with its membership of more than 16,000, the seven Sections and Division of Mycology do not serve adequately to cover the important and many new fields of science and its rapidly broadening horizon of activities and of specialization. The Committee and the Council have received a number of requests from the members for changes and additions to the Sections. The Council has long realized that, for the Academy to continue to hold the interests of its members who are specialists in the many new fields being developed in science, this long overdue reclassification should be effectuated."

By means of these fourteen units, the Academy can continue to grow; increase its regular evening meetings and the number of conferences held annually; bring greater representation and scope to the fields of science considered at these meetings and conferences; and, for the publication program, by no means the least of our contributions to Science, issue monographs with a more varied coverage of science fields than in the past.

It will be noted that no previous announcement has been made concerning the new Divisions of Mathematics, Nuclear Physics, or Space Research. These are presently being organized and will become active during the present academic year.

Another step in further developing this pattern has been the decision of the Council to intensify and increase the number and quality of conferences held annually, thereby adding materially to the number of publications made available this year to the Membership.

During the past fiscal year, November 1, 1957 to October 31, 1958, the following twenty-six conferences were held by the Academy:

"Chlorothiazide and Other Diuretic Agents," November 8, 1957, Conference Chairman: Robert F. Pitts, Cornell University Medical College, New York, N. Y. Held in joint sponsorship with Merck, Sharp & Dohme, Research Laboratories, Rahway, N. J. and West Point, Pa.

"Nuclear Magnetic Resonance," November 22 and 23, 1957, Conference Co-Chairmen: H. S. Gutowsky, University of Illinois, Urbana, Ill., and F. C. Nachod, Sterling-Winthrop Research Institute, Rensselaer, N. Y.

"Hodgkin's Disease," November 25 and 26, 1957, Conference Chairman: Antonio Rottino, St. Vincent's Hospital, New York, N. Y. Held in joint sponsorship with The Damon Runyon Memorial Fund for Cancer Research, Inc., New York, N. Y.

"Photoreception," January 31, and February 1, 1958, Conference Chairman: Jerome J. Wolken, Eye and Ear Hospital and School of Medicine, University of Pittsburgh, Pittsburgh, Pa.

"Third Tissue Homotransplantation Conference," February 6 and 7, 1958, Conference Co-Chairmen: John Marquis Converse and Blair O. Rogers, Institute of Reconstructive Plastic Surgery, New York University-Bellevue Medical Center, and the Department of Surgery, New York University College of Medicine, New York, N. Y.

"Contributions of the Physical, Biological, and Psychological Sciences in Human Disability," February 10 and 11, 1958, Conference Co-Chairmen: Renato Contini, College of Engineering, New York University, New York, N. Y., and Sidney Fishman, Post-Graduate Medical School, New York University, New York, N. Y.

"The Uterus," February 12, 13, 14 and 15, 1958, Conference Co-Chairmen, Joseph T. Velardo, Yale University School of Medicine, New Haven, Conn., William B. Ober, College of Physicians and Surgeons, Columbia University, New York, N. Y., and Herbert G. Winston, Albert Einstein College of Medicine, Yeshiva University, New York, N. Y.

"Enzymes in Blood," February 26 and 27, 1958, Conference Chairman, Laurens P. White, Stanford University School of Medicine, San Francisco, Calif. Organizing Committee, Laurens P. White, Chairman; Oscar Bodansky, Sloan-Kettering Institute for Cancer Research, New York, N. Y.; William Fishman, Tufts University School of Medicine, Boston, Mass.; Efraim Racker, Public Health Research Institute, New York, N. Y.; and Felix Wróblewski, Sloan-Kettering Institute for Cancer Research, New York, N. Y.

"Conceptual and Methodological Problems in Psychoanalysis," March 4 and 5, 1958, Conference Chairman, Leopold Bellak, Altro Health and Rehabilitation Services, New York, N. Y.

"Surgical Convalescence," March 7 and 8, 1958, Conference Co-Chairmen, F. C. Dohan, School of Medicine, University of Pennsylvania, Philadelphia, Pa.; and N. Henry Moss, School of Medicine, University of Pennsylvania, and Albert Einstein Medical Center, Philadelphia, Pa. Held in joint sponsorship with The American College of Surgeons, Chicago, Ill.

"Screening Procedures for Experimental Cancer Chemotherapy," March 13, 14 and 15, 1958. Conference Chairman, C. Chester Stock, Sloan-Kettering Institute for Cancer Research, New York, N. Y. Organizing Committee: C. Chester Stock, Chairman, Harry Eagle, National Institute of Allergy and Infectious Diseases, Public Health Service, Bethesda, Md.; Karl Folkers, Merck, Sharpe and Dohme, Rahway, N. J. and West Point, Pa.; Theodore Hauschka, Roswell Park Memorial Institute, Buffalo, N. Y.; James F. Holland, Roswell Park Memorial Institute, Buffalo, N. Y.; Lloyd W. Law, National Cancer Institute, Public Health Service, Bethesda, Md.; Joseph Leiter, Cancer Chemotherapy National Service Center, Bethesda, Md.; Harold P. Rusch, McArdle Memorial Laboratory, University of Wisconsin, Madison, Wis.; Esmond E. Snell, University of California, Berkeley, Calif.; J. Walter Wilson, Brown University, Providence, R. I.; George W. Woolley, Sloan-Kettering Institute for Cancer Research, New York,

N. Y. Held in joint sponsorship with the Cancer Chemotherapy National Service Center, Bethesda, Md.

"Metabolic Factors in Cardiac Contractility," March 18 and 19, 1958, Conference Co-Chairmen, Menard M. Gertler, New York University-Bellevue Medical Center, New York, N. Y., and G. W. E. Plaut, New York University College of Medicine, New York, N. Y.

"Biology of the Amoeba," March 24 and 25, 1958, Conference Chairman, H. I. Hirshfield, New York University, New York, N. Y.

"Axenic Culture of Invertebrate Metazoa: A Goal," April 7 and 8, 1958, Conference Chairman, Ellsworth C. Dougherty, Laboratory of Comparative Physiology and Morphology of the Kaiser Foundation, University of California, Berkeley, Calif. Held in joint sponsorship with The Kaiser Foundation, Oakland, Calif.

"The Analysis of Mixtures of Volatile Substances," April 10 and 11, 1958, Conference Chairman, Emil F. Williams, American Cyanamid Company, Stamford, Conn.

"The Influence of Hormones on Lipid Metabolism in Relation to Arteriosclerosis," April 11 and 12, 1958, Conference Co-Chairmen; Abraham Dury, Bradford Hospital, Bradford, Pa., and Carleton R. Treadwell, The George Washington University School of Medicine, Washington, D. C.

"Hematopoietic Mechanisms," May 1 and 2, 1958, Conference Co-Chairmen, Albert S. Gordon, New York University, New York, N. Y., and Walter S. Root, College of Physicians and Surgeons, Columbia University, New York, N. Y.

"Psoriasis," May 9, 1958, Conference Chairman, Peter Flesch, University of Pennsylvania, Philadelphia, Pa.

"Germfree Vertebrates: Present Status," May 15 and 16, 1958, Conference Chairman, James A. Reyniers, Lobund Institute, University of Notre Dame, Notre Dame, Ind.

"The Basic and Clinical Research of the New Antibiotic, Kanamycin," July 10 and 11, 1958, Conference Chairman, Maxwell Finland, Thorndike Memorial Laboratory, Boston, Mass. Held in joint sponsorship with the Bristol Laboratories, Syracuse, N. Y.

"Chlorpropamide and Diabetes Mellitus," September 25, 26 and 27, 1958, Conference Chairman, Martin Goldner, Jewish Chronic Disease Hospital, Brooklyn, N. Y. Held in joint sponsorship with Chas. Pfizer and Co., Inc., Brooklyn, N. Y.

"Second Conference on Physicochemical Mechanism of Nerve Activity," October 2 and 3, 1958, Conference Chairman, David A. Nachmansohn, College of Physicians and Surgeons, Columbia University, New York, N. Y.

"Second Conference on Muscular Contractions," October 3 and 4, 1958, Honorary Chairman, Wallace O. Fenn, University of Rochester School of Medicine and Dentistry, Rochester, N. Y.; Conference Chairman, Alexander Sandow, New York University, New York, N. Y.

"Trophoblast and Its Tumors," October 10 and 11, 1958, Conference Chairman, William B. Ober, Knickerbocker Hospital, College of Physicians and Surgeons, Columbia University; Albert Einstein College of Medicine, Yeshiva University, New York, N. Y.

"Enzymes of Polynucleotide Metabolism," October 16, 17 and 18, 1958, Conference Chairman, Jay S. Roth, Hahnemann Medical College, Philadelphia, Pa. Organizing Committee, Jay S. Roth, Chairman, C. B. Anfinsen, Jr., National Heart Institute, Public Health Service, Bethesda, Md.; L. A. Heppel, National Institute of Arthritis and Metabolic Diseases, Public Health Service, Bethesda, Md.; M. Laskowski, Marquette University School of Medicine, Milwaukee, Wis.; Severo Ochoa, New York University College of Medicine, New York, N. Y.

"Radiopaque Diagnostic Agents," October 24 and 25, 1958, Conference Chairman, Maxwell H. Poppel, New York University-Bellevue Medical Center, New York, N. Y.

A total of 698 papers was presented at these conferences at which the registered attendance totaled 7,325.

This section of the Recording Secretary's report would be incomplete without expressing the thanks and appreciation of the Council to the 1,045 scientists who participated in the programs, including the 94 investigators who represented 26 other countries.

In addition to these conferences, 483 meetings were held in the Academy Building during the past year. These not only covered Sectional meetings, conferences, Committee and Council meetings of the Academy, but 320 were those of 56 other Societies to which the accommodations of the Building were extended.

In furtherance of the aims of providing these important conferences and meetings for the membership, the publication of the resulting monographs in the *Annals* and reports in the *Transactions* has been carried out with very substantial progress in the timing and distribution as well as in the quality and a significant increase in the total volume of pages published. With those monographs that appeared in November 1958, 7,491 pages were published and distributed to the Members as part of the privileges extended by the Academy. Upon publication, the 36 monographs offered to the Membership for 1958 will exceed 10,000 pages. The number of copies distributed to the Members and authors will total more than 300,000 copies.

The Academy and five of its well-known Members actively participated with the science teachers in the high schools of New York City and held three evening symposia dealing with subjects in biology and biochemistry. This cooperative activity was enthusiastically received and well attended.

As in the past, special emphasis has been placed within the planning of the Council that the requests of the Membership be met in the most efficient and economical manner. The staff of the Academy has been organized and trained toward this end.

In planning for the continued growth of the activities of the Academy, it has long been realized that the dues from the Annual Active and Sustaining Membership have been too low for the services and publications made available. The willingness to increase the dues was not a decision easily arrived at by the Council, but the Membership has the assurance of the continued endeavor of the Council and the Staff to make Membership in the Academy an affiliation of value in the return of benefits and privileges to each Member.

Success was again evident in the increase of the Membership of the Academy. During the year ending October 31, 1958, 2,941 new Members were added to the rolls as follows: 3 Honorary Life Members; 8 Active Life Members; 158 Sustaining Members; 2,707 Annual Active Members; 65 Student Members. Ninety-nine former Members were reinstated, thus making a total of 3,040 names added to the current Membership rolls. Thirty-two transfers were effected in the Annual classes and 1 Sustaining Member and 1 Annual Active Member were transferred to Active Life Membership.

The Academy lost by death 1 Patron, 4 Honorary Life Members, 3 Active Life Members, 5 Sustaining Members, and 62 Annual Active Members. Four hundred and eighty-one resignations were accepted and 379 members were dropped as not having paid dues or for not having qualified for Membership.

The Academy now stands with a net gain of 2,105 Members for the current year. There are at present upon the rolls of the Academy 16,017 Members, of whom 1,411 are Fellows, classified as follows:

1 Gold Card Member	400 Active Life Members
3 Benefactors	613 Sustaining Members
2 Patrons	14,763 Annual Active Members
68 Honorary Life Members	159 Student Members
8 Corporation Members	

Record is made with regret of the loss by death of the following Members:

Patron

George W. Merck, elected to Active Membership 21 November 1946; transferred to Patron Membership 5 August 1949. Died 9 November 1957. Fellow.

Active Life Members

Robert Chambers, elected to Active Membership 28 February 1946; transferred to Life Membership 28 January 1954. Died 23 July 1957. Fellow.

Michael Ladd, elected to Life Membership 25 October 1956. Died 1 December 1956.

George B. Pegram, elected to Associate Membership 6 November 1916; transferred to Sustaining Membership 27 October 1938; transferred to Life Membership 21 November 1957. Died 12 August 1958. Fellow. Served as Vice-President and Chairman 1918, Section of Astronomy, Physics and Chemistry; Councilor 1917-1919; Recording Secretary, 1947-1948; Vice-President, 1949-1950; President, 1952; Past President on the Council 1953-1954.

Sustaining Members

Rudolf Leiser, elected to Sustaining Membership 27 October 1955. Died 22 April 1957.
Seth Minot Milliken, elected to Sustaining Membership 6 April 1925. Died 18 November 1957.
Harold M. Rabinowitz, elected to Sustaining Membership 28 February 1946. Died 10 March 1958.
Simon L. Ruskin, elected to Sustaining Membership 24 January 1946. Died January 1958.
Fred Schmitz, elected to Sustaining Membership 28 February 1957. Died July 1958.

Active Members

José Luis Arteta, elected to Active Membership 28 March 1957. Died July 1957.
Ernst Artschwager, elected to Active Membership 15 May 1957. Died June 1957.
James A. Austin, elected to Active Membership 23 April 1953. Died 11 February 1957.
Felix Baum, elected to Active Membership 15 July 1954. Died January 1958.
George A. Bennett, elected to Active Membership 17 May 1954. Died 27 February 1958.
Ralph W. Black, elected to Associate Membership 3 April 1939; transferred to Active Membership 15 July 1948. Died 27 April 1958.
Maurice Bruger, elected to Active Membership 13 June 1952. Died 26 November 1957.
Shalva D. Chachutov, elected to Active Membership 15 September 1955. Died March 1958.
Ettore Ciampolini, elected to Associate Membership 12 June 1941; transferred to Active Membership 15 May 1952. Died November 1957.
Alfred E. Cohn, elected to Active Membership 26 April 1928. Died 20 July 1957. Fellow.
Dean A. Collins, elected to Active Membership 25 January 1951. Died 3 December 1957.
Francesco Duran-Reynals, elected to Active Membership 15 June 1948. Died 27 March 1958. Fellow.
Stanley H. Durlacher, elected to Active Membership 15 August 1947. Died 19 March 1957.
Earl W. Flosdorf, elected to Associate Membership 1 April 1940; transferred to Active Membership 22 January 1948. Died 29 April 1958. Fellow.
Claude Fromageot, elected to Active Membership 20 November 1952. Died January 1958. Fellow.
Walter M. Fuchs, elected to Active Membership 27 October 1949. Died 30 August 1957.
Hugh William Garol, elected to Active Membership 24 February 1955. Died 14 February 1958.
Thomas A. Garrett, elected to Active Membership 24 January 1952. Died 15 January 1958.
Thomas J. Goodfellow, elected to Active Membership 3 November 1941. Died 19 January 1957.
Herbert L. Goodman, elected to Active Membership 27 January 1955. Died 15 April 1958.
William H. Gordon, elected to Active Membership 3 November 1941. Died January 1958.
Fred B. Harrington, elected to Active Membership 24 February 1955. Died 24 December 1957.
Newman A. Hoopingarner, elected to Student Membership 4 March 1941; transferred to Active Membership 25 March 1948. Died 27 January 1958.
William W. Hosler, elected to Active Membership 23 April 1953. Died 9 June 1958.
Christine Jan Ivanov, elected to Active Membership 15 August 1956. Died 31 July 1957.
Vladimir A. Kalichevsky, elected to Active Membership 15 August 1957. Died 4 February 1958.
Edward J. Keegan, elected to Active Membership 16 May 1941. Died 27 October 1957.
John Allen Killian, elected to Active Membership 1 May 1940. Died 2 December 1957.
Roland M. Klemme, elected to Active Membership 25 October 1956. Died November 1957.
Ernst Kris, elected to Active Membership 23 March 1944. Died February 1957.
Herbert S. Langfeld, elected to Active Membership 5 May 1941. Died 25 February 1958.
Daniel Laszlo, elected to Active Membership 28 March 1946. Died 1 June 1958.
Deborah C. Leary, elected to Active Membership 25 October 1956. Died 30 October 1957.
Alfred J. Liebmann, elected to Active Membership 13 September 1946. Died October 1957.
Sarantos Loumos, elected to Active Membership 26 April 1956. Died May 1958.
Lawson G. Lowrey, elected to Active Membership 7 April 1941. Died February 1958. Fellow.
Thomas McC. Mabon, elected to Active Membership 22 October 1953. Died September 1958.
Carl Danforth Miller, elected to Active Membership 28 January 1943. Died 30 March 1957.
Frank B. Morrison, elected to Active Membership 15 July 1957. Died 7 April 1958.
Ralph Thomas Nazzaro, elected to Active Membership 14 December 1956. Died 21 January 1958.
Nicholas E. Oglesby, elected to Active Membership 16 May 1944. Died 8 March 1957.
Edward H. Oppenheimer, elected to Active Membership 23 February 1956. Died May 1958.
Catharine Patrick, elected to Section Membership 3 May 1937; transferred to Active Membership 26 February 1948. Died 8 April 1957.

John J. Prendergast, elected to Active Membership 15 August 1955. Died February 1958.
Charlotte Preuss, elected to Active Membership 4 March 1929. Died 29 December 1957.
Joseph Preuss, elected to Active Membership 22 January 1953. Died 30 March 1958.
John Quaranta, elected to Active Membership 24 January 1952. Died 23 March 1958.
Geoffrey W. Rake, elected to Active Membership 23 March 1950. Died April 1958. Fellow.
Charles R. Rein, elected to Active Membership 25 January 1951. Died December 1957.
Ernest E. Rothe, elected to Active Membership 16 June 1947. Died 3 August 1957.
Rudolf Saliger, elected to Active Membership 23 February 1956. Died 31 January 1958.
Franklin L. Schacht, elected to Active Membership 24 January 1957. Died May 1957.
John A. Schindler, elected to Active Membership 15 December 1952. Died March 1958.
Wolfgang Seligmann, elected to Active Membership 15 May 1952. Died 22 December 1957.
Frank E. Stirn, elected to Active Membership 26 February 1948. Died 9 October 1958. Fellow.
L. R. Stowe, elected to Active Membership 17 May 1954. Died January 1958.
Maurice J. Strauss, elected to Active Membership 13 July 1951. Died 2 February 1958.
Charles Thom, elected to Active Membership 24 April 1952. Died May 1956. Fellow.
Sidney Trattner, elected to Active Membership 26 January 1956. Died February 1958.
Eilhard von Domarus, elected to Active Membership 25 January 1945. Died February 1958.
Davis C. Weaver, elected to Active Membership 23 February 1956. Died December 1957.
Marlin R. Wedemeyer, elected to Active Membership 15 August 1952. Died March 1958.
Frederick O. Zillessen, elected to Active Membership 13 December 1946. Died December 1957.

Report on the Status of Publications

During the fiscal year ending October 31, 1958, The New York Academy of Sciences has published 27 monographs in the *Annals*, 1 in the *Special Publications* and 1 in the *Scientific Survey of Porto Rico and the Virgin Islands*, comprising a total of 5,663 pages. Included in these are 462 papers by 768 authors. The pagination of the *Transactions* (859) brings the total pagination issued to 6,522 pages.

The list of publications issued during the fiscal year is as follows:

Annals

Volume 70, Article 2. *Structural Design Study for a Radio Telescope with a Paraboloid Reflector Six Hundred Feet in Diameter* (1 paper) by Jacob Feld. Pages 153-276. Published December 6, 1957.
Volume 69, Article 4. *Immunology and Cancer* (29 papers) by Jerome T. Syverton *et al.* Pages 525-856. Published December 16, 1957.
Volume 69, Article 5. *Protein Nutrition* (13 papers) by Fredrick J. Stare *et al.* Pages 855-1066. Published January 10, 1958.
Volume 71, Article 4. *Chlorothiazide and Other Diuretic Agents* (16 papers) by Robert F. Pitts *et al.* Pages 321-478. Published February 3, 1958.
Volume 72, Article 1. *Histochemical and Microchemical Observations on the Lipids of the Interscapular Brown Fat of the Female Vespertilionid Bat Myotis lucifugus lucifugus* (1 paper) by Guy-Laurent Rémillard. Pages 1-68. Published February 4, 1958.
Volume 72, Article 2. *The Paramagnetic Resonance and Optical Spectra of Some Ions in Cubic Crystalline Fields* (1 paper) by W. Low. Pages 69-126. Published March 17, 1958.
Volume 72, Article 3. *Recent Studies on the Epidemiology of Histoplasmosis* (1 paper) by Michael L. Furcolow. Pages 127-164. Published April 10, 1958.
Volume 72, Article 4. *Man in Space: A Tool and Program for the Study of Social Change* (6 papers) by Margaret Mead *et al.* Pages 165-214. Published April 10, 1958.
Volume 72, Article 5. *Half Life of Rhenium and Ages of Minerals* (1 paper) by Stanley N. Naldrett. Pages 215-226. Published April 15, 1958.
Volume 68, Article 3. *Comparative Clinical and Biological Effects of Alkylating Agents* (58 papers) by Leon H. Schmidt *et al.* Pages 657-1266. Published April 24, 1958.
Volume 70, Article 3. *Animal Disease and Human Health* (42 papers) by James Lieberman *et al.* Pages 277-762. Published June 3, 1958.
Volume 70, Article 4. *Nuclear Magnetic Resonance* (14 papers) by H. S. Gutowsky and Frederick C. Nachod *et al.* Pages 763-930. Published June 16, 1958.
Volume 71, Article 5. *New Steroid Compounds with Progestational Activity* (33 papers) by Abraham E. Rakoff and Edward C. Reifenstein, Jr. *et al.* Pages 479-806. Published July 30, 1958.
Volume 72, Article 6. *The Influence of Sulfhydryl Groups and Their Inhibitors on the Distribution of Radiocobalt in the Organs and Intracellular Organelles of the Mouse* (1 paper) by Laurence S. Maynard. Pages 227-238. Published August 29, 1958.
Volume 73, Article 1. *Hodgkin's Disease* (23 papers) by Antonio Rottino *et al.* Pages 1-380. Published September 5, 1958.
Volume 73, Article 2. *Surgical Convalescence* (18 papers) by F. Curtis Dohan and N. Henry Moss *et al.* Pages 381-538. Published September 10, 1958.
Volume 76, Article 1. *A Periodic Table for Fundamental Particles* (1 paper) by John J. Grebe. Pages 1-16. Published September 15, 1958.

Volume 71, Article 6. *Genetic Concept for the Origin of Cancer* (29 papers) by Leonell C. Strong *et al.* Pages 807-1241. Published September 30, 1958.
Volume 74, Article 1. *Contributions of the Physical, Biological, and Psychological Sciences in Human Disability* (19 papers) by Renato Contini and Sidney Fishman *et al.* Pages 1-160. Published September 30, 1958.
Volume 73, Article 4. *Basic Biodynamics* (1 paper) by Edward J. Kempf. Pages 869-910. Published September 30, 1958.
Volume 76, Article 2. *The Basic and Clinical Research of the New Antibiotic, Kanamycin* (39 papers) by Maxwell Finland *et al.* Pages 17-408. Published September 30, 1958.
Volume 73, Article 3. *Third Tissue Homotransplantation Conference* (38 papers) by John Marquis Converse and Blair O. Rogers *et al.* Pages 539-868. Published October 7, 1958
Volume 72, Article 7. *An Experimental Analysis of the Hypothalamic-Hypophysial-Thyroid Relationship in the Rat* (1 paper) by Savino A. D'Angelo and Ronald E. Traum. Pages 239-270. Published October 10, 1958.
Volume 75, Article 1. *Enzymes in Blood* (43 papers) by Laurens P. White *et al.* Pages 1-384. Published October 13, 1958.
Volume 72, Article 8. *Phenaglycodol Therapy in Cerebral Palsy* (1 paper) by I. Newton Kugelmass. Pages 271-292. Published October 15, 1958.
Volume 72, Article 9. *Lymphocytes and Plasmacytes in Nucleoprotein Metabolism* (1 paper) by Margaret A. Kelsall and Edward D. Crabb. Pages 293-338. Published October 25, 1958.
Volume 72, Article 10. *Quantum Aspects of Catalysis: Oxidations and Other Reactions of Ethylene* (1 paper) by Raymond R. Myers. Pages 339-352. Published October 25, 1958.

Special Publications

Volume V. *Cellular Biology, Nucleic Acids, and Viruses* (29 papers) by Thomas M. Rivers *et al.* Pages 1-414. Published November 14, 1957.

Scientific Survey of Porto Rico and the Virgin Islands

Volume VII, Part 4. *The Mosses of Porto Rico and the Virgin Islands* (1 paper) by H. A. Crum and W. C. Steere. Pages 395-599. Published December 13, 1957.

In addition to the publications cited above, the following monographs were published in the *Annals* during November and December 1958, after the close of the fiscal year:

Volume 73, Article 5. *Psoriasis* (11 papers) by Peter Flesch *et al.* Pages 911-1037. Published November 10, 1958.
Volume 74, Article 2. *Photoreception* (21 papers) by Jerome J. Wolken *et al.* Pages 161-406. Published November 12, 1958.
Volume 72, Article 11. *Rational Simplification for the Buckling Length of Columns* (1 paper) by Thomas C. Kavanagh. Pages 353-386. Published November 18, 1958.
Volume 76, Article 3. *Screening Procedures for Experimental Cancer Chemotherapy* (78 papers) by C. Chester Stock *et al.* Pages 409-970. Published December 4, 1958.

The number of pages of the four monographs listed above totals 969. This figure will be included in the pagination for the fiscal year 1958-1959.

Transactions

Series II, Volume 20, Numbers 1 to 8, consisting of 859 pages, covering the period from November 1957 to June 1958, inclusive, was completed, printed, and distributed during the calendar year.

Annals in Press

Volume 75, Article 2. *The Uterus* (44 papers) by Joseph T. Velardo *et al.* Awaiting publication January 5, 1959.
Conceptual and Methodological Problems in Psychoanalysis (6 papers) by Leopold Bellak *et al.* In page proof.
Axenic Culture of Invertebrate Metazoa: A Goal (26 papers) by Ellsworth C. Dougherty *et al.* In galley proof.
Metabolic Factors in Cardiac Contractility (17 papers) by Menard M. Gertler *et al.* In galley proof.
The Analysis of Mixtures of Volatile Substances (20 papers) by Emil F. Williams *et al.* In galley proof.
Chlorpropamide and Diabetes Mellitus (71 papers) by Martin Goldner *et al.* In galley proof.

From November 1, 1957, to October 31, 1958, the Academy distributed 1,303,338 separate publications of the various series as follows:

Distribution of Publications
11/1/57 to 10/31/58

	Separate Numbers
Annals	
Members	101,830
Gratis: Authors, reviews, exchanges and donors	21,978
Sales	219,566
Authors' reprints	693,500
Transactions	
Members	118,364
Gratis: Authors, exchanges, reviews	2,605
Sales	1,828
Authors' reprints	13,650
Special Publications, Volume I, III, IV, V	
Sales	1,399
Gratis	188
Authors' reprints	9,350
Scientific Survey of Porto Rico and the Virgin Islands	
Gratis	4
Sales	682
Monthly Program	
Members	116,488
Sales	604
Gratis: individuals	1,302
	1,303,338

In addition to sales, the total *list* value of those publications distributed to the Members, and gratis to authors, donors, reviews and exchange institutions is $451,761.03.

Election of Fellows and Honorary Life Members

The following Members were elected to Fellowship:

Altschule, Mark D., M.D.
Barziali, Gemma, M.D.
Baum, Samuel Meyerson, M.D.
Baumeister, Theodore, M.E.
Bellet, Samuel, M.D.
Bowman, Robert L., M.D.
Brodsky, Ralph Howard, D.M.D.
Casarett, George W., Ph.D.
Cattell, Raymond Bernard, D.Sc.
Chamlin, Max, M.D.
Cutting, W. C., M.D.
Deitrick, John E., M.D.
Edsall, Geoffrey, M.D.
Gantt, W. Horsley, M.D.
Grebe, John G., D.Sc.
Greene, Harry S. N., M.D.
Moldaver, Joseph, M.D.
Montroll, Elliott W., Ph.D.
Muehlhause, Carl O., Ph.D.
Packard, David, B.C.
Peaslee, David C., Ph.D.
Piore, Emanuel R., Ph.D.
Powell, Wilson M., Ph.D.
Rantz, Lowell A., M.D.
Ray, Clarence T., M.D.
Regener, Victor H., Dr.Ing.
Reichert, Frederick L., M.D.
Roberts, Bruno R., Ph.D.
Ruchman, Isaac, Ph.D.
Ruderman, I. Warren, Ph.D.
Sacher, Alex, Ph.D.
Saphir, Otto, M.D.

Griffith, George C., M.D.
Haworth, Leland J., Ph.D.
Hecht, Hans H., M.D.
Hufnagel, Charles A., M.D.
Hurwitz, Henry, Jr., Ph.D.
Hutchisson, Elmer, Ph.D.
Jette, Eric R., Ph.D.
Karsner, Howard T., M.D.
Kenyon, John N., Ph.D.
Koree, Jean U., Ph.D.
LaDue, John S., M.D.
Lempert, Julius, M.D.
Madey, Richard, Ph.D.
Marinsky, Jack A., Ph.D.
Mateyko, Gladys M., Ph.D.
Menke, John Roger, B.S.
Millikan, Clark H., M.D.
Schmidt, Carl F., Sc.D.
Schmidt-Nielsen, Bodil, D.D.S.
Sebrell, William H., Jr., D.Sc.
Seegers, Walter, Ph.D.
Skelton, Floyd R., M.D.
Swan, Henry, M.D.
Thienes, Clinton H., Ph.D.
Thompson, Helen, Ph.D.
Tobian, Louis, Jr., M.D.
Van Wagtendonk, W. J., Ph.D.
Van Winkle, Walton, Jr., M.D.
Visscher, Maurice B., Ph.D.
Weiss, Charles, M.D.
Wohl, Michael G., M.D.
Wynder, Ernest L., M.D.
Young, Frederick P., Ph.D.

Honorary Life Memberships were conferred upon the following eminent scientists:

Isaac Berenblum, Weizmann Institute of Science, Rehovoth, Israel.
Sir John Douglas Cockcroft, Atomic Energy Establishment, Harwell, England.
Alexander Nikolaevich Nesmeyanov, Academy of Sciences, Union of Soviet Socialist Republics.
Ernst Harald Norinder, Uppsala University, Uppsala, Sweden.
Francis Perrin, French High Commissioner for Atomic Energy, Paris, France.
Lord Bertrand Arthur William Russell, Trinity College, Cambridge, England.
Hideki Yukawa, Kyoto University, Tokyo, Japan.

Election of Officers

Report of the Tellers

The tellers appointed by President Pregel to count the ballots for the election of Officers and other Members of the Council to serve for the year 1959 report that the names on the Official Ballot, as printed and distributed, were elected by the votes of the 3,329 ballots returned by the Membership.

The list thus chosen by the Membership of the Academy for the year 1959 is as follows:

President-Elect
M. J. KOPAC

Vice-Presidents
LYLE BORST — C. P. RHOADS

Recording Secretary
EMERSON DAY

Corresponding Secretary
FREDERICK Y. WISELOGLE

Treasurer
GUSTAV J. MARTIN

Councilors (1959-1961)
JOHN E. DEITRICK
ROBERT S. MORISON
CHARLES W. MUSHETT
E. L. TATUM

Finance Committee
HARDEN F. TAYLOR, *Chairman*

GORDON Y. BILLARD ROBERT F. LIGHT

Chairmen of Sections and Divisions
ROBERT L. KROC, *Section of Biological and Medical Sciences*
DOROTHY L. KEUR, *Division of Anthropology*
DUNCAN A. HOLADAY, *Division of Instrumentation*
KARL MARAMOROSCH, *Division of Mycology*
GREGORY RAZRAN, *Division of Psychology*
KARL FOLKERS, *Section of Chemical Sciences*
KURT LOWE, *Section of Geological Sciences*
ABRAHAM S. KUSSMAN, *Division of Oceanography and Meteorology*
EMANUEL R. PIORE, *Section of Physical Sciences*
THOMAS B. DREW, *Division of Engineering*

Note. The newly established Division of Biochemistry, the Division of Mathematics, the Division of Nuclear Physics and the Division of Space Research are now being organized and, as soon as a regular meeting night and initial program for each have been set up, announcement will be made in the *Monthly Program.*

Awards for 1958

(1) *The A. Cressy Morrison Awards in Natural Science.* After careful consideration and comparison of the eligible papers presented in competition this year, the Committee unanimously made the following awards:

An award of $400 to Raymond R. Myers, William H. Chandler Chemistry Laboratory, Lehigh University, Bethlehem, Pa., for the paper *Quantum Aspects of Catalysis: The Drying of Linseed Oil.*

An award of $400 to Henry Tolkmith, Dow Chemical Company, Midland, Mich., for the paper *Bond Refraction, Bond Nature, and Structure of Organophosphorus Compounds.*

(2) *The George Frederick Kunz Award in Geology and Mineralogy.* An award of $400 to H. D. Thompson, Department of Geology, Hunter College, New York, N. Y., for the paper *The Palisades Ridge in Rockland County, New York.*

(3) *The Boris Pregel Award in the Field of Natural Radioactive Substances.* No papers were received in competition for this award.

(4) *The D. B. Steinman Award for Research in Structural Engineering.* An award of $500 to L. Albert Scipio II, Department of Aeronautical Engineering, Institute of Technology, University of Minnesota, Minneapolis, Minn., for the paper *On the Design of Structural Models to Study Thermal Stress Phenomenon.*

(5) *The Consumers Union Award in Consumers Research.* Since no paper completely fulfilling the conditions for competition was presented to the Academy during 1958, the Committee made no award in this field.

Abstracts of 1958 Award Papers

QUANTUM ASPECTS OF CATALYSIS: THE DRYING OF LINSEED OIL

Raymond R. Myers*

Accorded an A. Cressy Morrison Award in Natural Science, 1958

Various explanations of the mechanism of the drying of oleoresinous vehicles have been proposed, but few explanations of the role of the catalyst have been advanced. The success with which various reactions of a relatively simple molecule such as ethylene have been explained on the basis of quantized transfers of mass has led to a similar study of the more complex reaction of linseed oil with oxygen.

BOND REFRACTION, BOND NATURE, AND STRUCTURE OF ORGANOPHOSPHORUS COMPOUNDS

Henry Tolkmith†

Accorded an A. Cressy Morrison Award in Natural Science, 1958

Based upon the fundamental work of C. P. Smyth and K. G. Denbigh, a comprehensive system of bond refractions has been elaborated by A. I. Vogel. This system has made it possible to calculate molecular refractions for a large variety of organic, organometallic, and organometaloid compounds with simplicity as well as accuracy. However, it has not provided data on refractions of phosphorus bonds.

In the past it was customary to calculate molecular refractions of organophosphorus compounds from a set of atomic refractions tentatively established by W. J. Jones and extensively developed by M. I. Kabachnik. This system proved to be quite useful for checking the purity of a member of a given type of compound. Beyond this, the values of atomic refractions of phosphorus had no meaning. It is conceivable, however, that bond refractions could have additional significance. Recently, two attempts were made to determine values of refractions for some phosphorus bonds. These data concerned the P–H, P–C, P=O, and P–O ester bonds. Calculation of theoretical molecular refractions (M_R) of various types of compound from these data gave values that deviated substantially from experimental results.

*William H. Chandler Chemistry Laboratory, Lehigh University, Bethlehem, Pa.
†Dow Chemical Company, Midland, Mich.

THE PALISADES RIDGE IN ROCKLAND COUNTY, NEW YORK

H. D. Thompson*

Accorded the George Frederick Kunz Award in Geology and Mineralogy, 1958

This report on that portion of the Palisades Ridge that lies in Rockland County, N. Y., suggests new interpretation of certain structural aspects and of the relationships of topographic features to these structures. Vertical offsets of the base of the diabase sill that forms the ridge were formerly attributed to lateral migration of the intrusion across the sediments. This study shows that the offsets coincide with, and are the result of, high-angle faulting. Differential weathering and erosion along these transverse faults are the most reasonable explanation for the prominent gaps in the ridge, which have previously been interpreted as parts of former stream systems. Oversteepened slopes and discordant contacts on the back (dip) slope of the ridge coincide with longitudinal (strike) faults instead of representing a feeding dike cutting steeply across the sedimentary rocks. In the westward swing of the northern end of the ridge the diabase continues as a sill, faulted on the south side of the ridge, rather than cutting across the sediments as a dike. At the western terminus of the ridge the sill is abruptly carried below ground level by downfaulting.

Calculations of the thickness of the sill show that it thins northward and westward from about 900 feet at Sparkill to about 400 feet at Mt. Ivy.

Glacial striae show that topography had strong local influence in deflecting the ice movement from its regional course. Ice erosion is probably responsible for some of the oversteepened slopes; ice deposition has concealed most of the bedrock in the lowlands.

ON THE DESIGN OF STRUCTURAL MODELS TO STUDY THERMAL STRESS PHENOMENON

L. Albert Scipio II†

Accorded the D. B. Steinman Award for Research in Structural Engineering, 1958

This paper considers the similarity parameters necessary for investigation of thermal stresses and strains produced in free flight due to aerodynamic heating.

Two general types of structures are considered: (1) solid or thick skin; and (2) shell or thin skin structures. For solid or thick skin struc-

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tures, it is assumed that all dimensions are scalable by the same scale factor (model scale). For shell structures, it is assumed that all linear dimensions of the prototype except the skin and web thicknesses are scalable by the model scale.

The attendant rules for construction of a model having the requisite similarity to each of the above types of structures establish conditions for an experimental study of the structural behavior and integrity of various types of aircraft and missiles.

The results indicate that similarity between model and prototype is possible in each case for thermal stress investigations. However, similarities of the deformation field of thermal origin and that due to mechanical surface stress can be achieved only with different scale factors. The applicability of the similarity laws is discussed, in particular, similarity of the combined thermal and mechanical stress fields.

THE NEW YORK ACADEMY OF SCIENCES

announces

FOUR SCIENTIFIC AWARDS FOR 1959

The New York Academy of Sciences announces the following four awards for the coming year.

I. THE A. CRESSY MORRISON AWARDS IN NATURAL SCIENCE

Two awards of $400 each, to be known as THE A. CRESSY MORRISON AWARDS IN NATURAL SCIENCE, will be announced at the Annual Meeting of The New York Academy of Sciences in December 1959 for the two most acceptable papers in a field of science covered by the Academy or an Affiliated Society.

II. THE BORIS PREGEL AWARD IN THE FIELD OF NUCLEAR PHYSICS AND NUCLEAR ENGINEERING

Through the generosity of Dr. Boris Pregel, an award of $500 is offered for the most acceptable paper embodying the results of research in the field of nuclear physics and nuclear engineering received during the year 1959. Announcement of this award will be made at the Annual Meeting of the Academy in December 1959.

III. THE D. B. STEINMAN AWARD FOR RESEARCH IN STRUCTURAL ENGINEERING

Through the generosity of Dr. D. B. Steinman, an award of $500 is offered for the most acceptable original paper submitted from the Membership of the Academy in the field of pure or applied research in structural engineering, or in the related science of aerodynamics, or as applied to the analysis and design of civil engineering structures. The purpose is to encourage research, development, and writing in the subject of engineering sciences. This award will be announced at the Annual Meeting of the Academy in December 1959.

IV. THE CONSUMERS UNION AWARD IN CONSUMER RESEARCH

Through the generosity of Consumers Union, an award of $1,000 is offered for the most acceptable paper on the subject "Science and the Consumer" submitted from the membership of the Academy. Consumers Union offers this award with the purpose of focusing on the practical applications of science to the needs of the consumer or on the concepts of science in terms of the consumer interest. This award will be announced at the Annual Meeting of the Academy in December 1959.

CONDITIONS GOVERNING THESE AWARDS

(1) *Eligibility.* Authors and co-authors applying for awards I, III, and IV shall be members in good standing of The New York Academy of Sciences or one of its Affiliated Societies, but nonmembers may become eligible by joining one of these organizations before the closing date.

All scientists engaged in research in the field of nuclear physics and nuclear engineering may make application for award II.

(2) *Date.* Papers are to be submitted on or before October 15, 1959 to the Executive Director of The New York Academy of Sciences, 2 East Sixty-third Street, New York 21, N. Y.

(3) *Papers.* All papers submitted must embody the results of original research not previously published. The manuscript shall be typewritten, double spaced on bond paper, in English, and accompanied by all necessary photographs, drawings, diagrams, and tables, and shall be ready for publication. Papers must be accompanied by a summary of the data presented and conclusions reached.

(4) *Awards.* The awards shall be made by the Council of The New York Academy of Sciences, and its decision shall be final.

(5) *Publication.* The Academy shall have first option on the publication of all papers submitted unless other special arrangements have been made beforehand with the authors, but such publication is not binding on the Academy.

(6) Wherever and whenever published, the papers receiving the awards shall be accompanied by one of the four following statements:

Under award I, "Accorded an A. Cressy Morrison Award in Natural Science in 1959 by The New York Academy of Sciences;"

Under award II, "Accorded a Boris Pregel Award for Research in Nuclear Physics and Nuclear Engineering in 1959 by The New York Academy of Sciences;"

Under award III, "Accorded a D. B. Steinman Award for Research in Structural Engineering in 1959 by The New York Academy of Sciences;"

Under award IV, "Accorded a Consumers Union Award in Consumer Research in 1959 by The New York Academy of Sciences."

Such a statement, in substance, must also accompany any formal publicity initiated by the author regarding the award paper. If published elsewhere with the consent of The New York Academy of Sciences, six copies of each award paper must be deposited shortly after publication with the office of The New York Academy of Sciences.

THE NEW YORK ACADEMY OF SCIENCES
2 East Sixty-third Street
New York 21, N. Y.

Eunice Thomas Miner
Executive Director

Remarks by the President

EXPANSION OF THE ACADEMY'S ACTIVITIES

We arrive at a story of progress. We shall give you a clear picture of the success the Academy has had; we can all be proud of it.

Taking 1950 as a starting point, the year the Academy moved into this building, I shall compare its activities then with what has been accomplished during the fiscal year 1958.

After studying this comparison, I am confident that you will agree with me that if anyone in 1950 had dared to predict the present scope of the Academy's activities, he would have been consigned *ipso facto* to a lunatic asylum.

Keeping in mind that the principal reason for the Academy's existence is the dissemination of scientific data to active workers in scientific fields, I should like to call your particular attention to the achievements of the Academy.

First, our rapidly growing membership provides an ever-increasing audience of investigating and practicing scientists who receive the Academy's services. In 1950 we had 5,447 members. On October 31, 1958, we had 16,086 (see Chart A). Tripling the membership was accomplished without the benefit of membership drives or the use of other sales promotion methods. It must, therefore, be a true measurement of a widening interest among scientists in having the Academy's data available to them. In turn, this is confirmation of the fact that the Academy's services to its members are valuable; they would not be sought if they were not.

Second, the sale of publications to nonmembers has increased at an even more remarkable rate. In 1950, these sales brought in a total of $42,000; in 1958 the total was $265,283 (see Chart B). This sixfold increase clearly indicates an additional audience in rapidly growing numbers which is seeking the Academy's data. It is also, of course, clear evidence of the excellent quality of these publications.

And third, the conferences conducted by the Academy have increased from 3 in 1950 to 26 in 1958 for the most rapid rate of growth of all the achievements. This increase of 8 times is truly impressive because it has been accomplished without any compromise of the very highest standards that the Academy has always used in selecting as its speakers the outstanding scientists in the world.

The Academy's activities must be supported and it is natural, therefore, that both the budget and the staff have increased. Progress could not have been made otherwise. In 1950 the budget was $116,429, in 1958 it was $571,595, and in 1959, $819,733; and the staff has increased from 16 to 62 in the same period. This is a remarkable record for any organization.

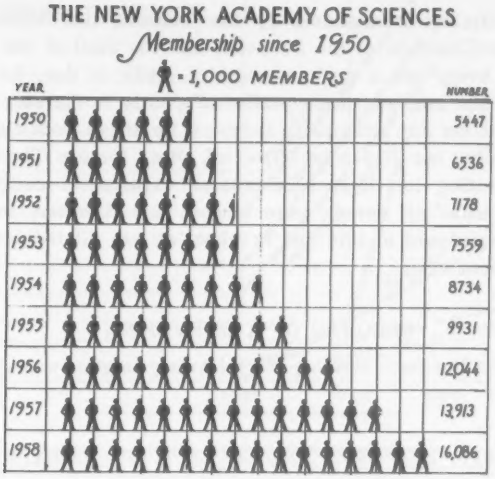

Chart A

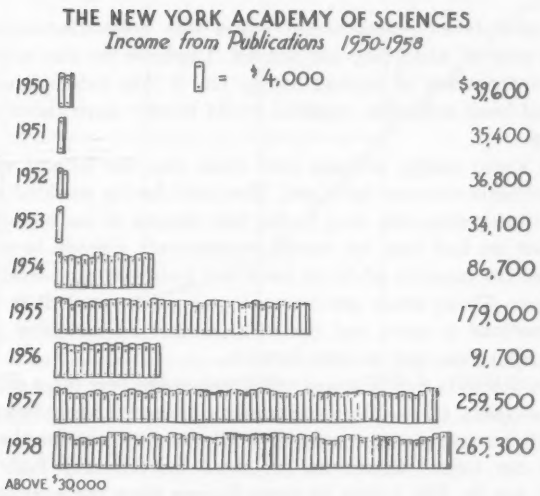

Chart B

I have been explaining the expansion in the life blood activities of the Academy during the past eight years, but I feel that you will all agree with me that this success did not happen casually or without direction. On the contrary, every step upward is a reflection of hard thinking, hard

work, and efficient management by the Council, the Officers of the Academy, the Chairmen of the Sections, and the Staff of the Academy; to each and every one a great measure of credit is due, for each and every one in his own way has contributed greatly to the success of the Academy. But we are principally indebted for these conditions to one person, namely, our Executive Director, Mrs. Eunice Thomas Miner, whose penetrating intelligence, extensive experience, complete dedication, and unfailing energy have carried this Academy forward and upward at an unheard of rate and to whom we are all indebted for this splendid performance.

PROGRAM OF THE EVENING

After the Business Meeting the following program was given:

ENERGY, ECONOMY, AND SOCIETY IN TRANSITION*

Boris Pregel

Retiring President, The New York Academy of Sciences, New York, N. Y.

It is an established philosophical axiom that great discoveries are made at the moment when they are needed. I believe we can apply this maxim to the discovery of nuclear energy for, if this indispensable advance had not been achieved, mankind would shortly have faced a most somber future.

As we all know, energy in some form other than the filtered sunlight that photosynthesis converts into food, fiber, and fuel is mankind's basic resource. We are presumably only in the first stages of our evolution on this earth, but we find that our energy requirements already have grown almost beyond the capacity of fossil fuels and hydroelectric installations to satisfy them. These needs are increasing at great speed. It is certain they will continue to grow and that they cannot be met from present sources for more than one or two decades.

The United States is rich in power and it possesses very large resources of all kinds of fossil fuels. Thus, to acquire a conservative understanding of the world's energy needs, it may be worthwhile to examine the added demands of the United States as projected for the very near future (FIGURES 1 and 2). The curves in these figures show the available and the projected levels of fuels, in B.T.U. units, needed by the United States at the dates indicated. The curves are based on data published in

*A paper entitled "Scientific Writing and Reporting" was presented at the Annual Meeting, December 4, 1958, by William L. Laurence, Science Editor, New York Times, New York, N. Y. This article will not be published by the Academy.

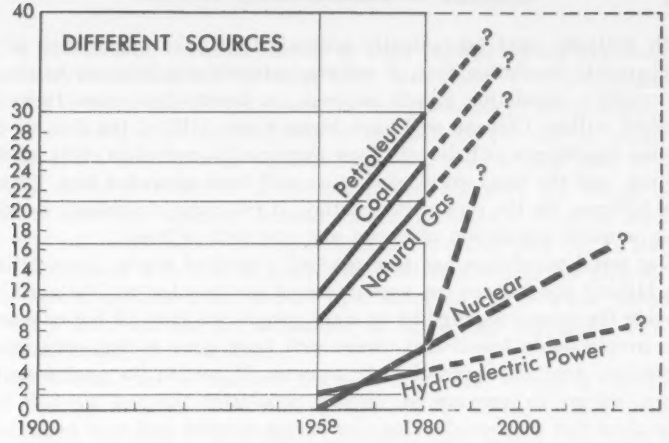

FIGURE 1. Actual and future consumption of energy in the United States, expressed in trillions of B.T.U. Based on the McKinney Report on Peaceful Uses of Atomic Energy.

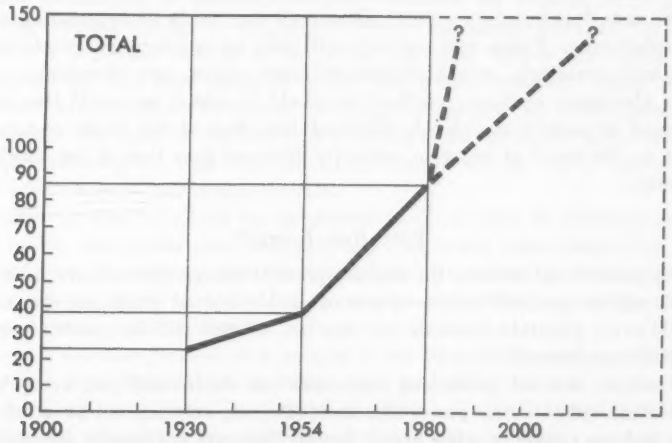

FIGURE 2. Total actual and future consumption of energy in the United States, expressed in trillions of B.T.U. Based on the McKinney Report on Peaceful Uses of Atomic Energy.

the McKinney report on peacetime uses of atomic energy and are, I may suggest, very conservative.

With these data in mind, we may reflect for a moment on the potential energy requirements, even in the next twenty-five years, of the six hundred million Chinese, the five hundred million inhabitants of India, and all the other millions in Asia, in Africa, and in Central and South America. Any

such estimate must be radically revised if we take cognizance of the demographic prediction that, if nothing extraordinary happens to change the world's population growth patterns, in twenty-five years these six hundred million Chinese will have become one billion, the five hundred million inhabitants of India will have increased to more than eight hundred million, and the total world population will have expanded from three to five billions. By the turn of the century, if the curve continues, we shall have a world population of seven and one half billions.

Our world population has now reached a total of almost three billion, the highest point since the appearance of our species on this earth. To provide the energy required by so many people, we have all but exhausted our irreplaceable fossil fuel stores and have gone a long way toward exploiting available hydroelectric sources. If, within the next forty-two years, we are to increase our present population two and one-half fold, it is clear that we must develop new energy sources and must begin to do so immediately. In this report, I propose to consider in some detail the form of the new energy and some of its possible effects on our economy, our politico-social organizations, and our culture.

We must keep in mind that, when we speak of nuclear energy, we imply great new developments also in almost all the fields of application and manufacturing. These new methods will help to develop and create new synthetic materials, new high-heat-resistant alloys, new chemicals, and new electronic devices, so that the world in which we shall live will present an aspect completely different from that of the world of today, just as the world of today is radically different from that of the Twelfth Century.

What New Energy?

As pointed out earlier, the world's present energy sources are limited. Although we may still discover new oil fields or coal veins and may also build every possible hydroelectric station, all this will be insufficient to satisfy our demands.

Even if new oil fields and coal beds are discovered and every last potential hydroelectric power site is developed, we shall not have solved the problem except in a few areas. Fossil fuels are not evenly distributed over the world, nor are water-power sites, so that certain areas of the world will be in the same catastrophic situation they now face, or in a worse one. The era of imbalance between have and have-not nations is ending. The new energy source, if it is to contribute to the welfare of mankind, must tend to equalize the imbalance that has hitherto existed. The tides, the sun, and the wind are being explored as possible sources of new energy. All of these sources are promising, but extensive research and development will be required to make them practicable. The only new source of energy that is available almost immediately and that can meet the requirements of the have-not nations is nuclear energy.

The fundamental research needed to make nuclear energy available to men everywhere has, for the most part, been done. The developmental research is under way. Prototypes of nuclear power plants are in operation, and there remains no problem that is not well on the way to solution.

What of the cost of such plants? There has been a great deal of discussion about this aspect of nuclear power, but very few sound conclusions have been reached. Actually, a discussion of the cost of nuclear power is not essential at this time. Whatever the cost may be, no matter how it compares with that of power produced in conventional plants, we shall have to produce it and pay for it, whether we like it or not, because we shall need the energy. Expansion of our energy resources will be essential to our very existence.

Nevertheless, let us analyze the cost of nuclear energy as best we can, keeping in mind, as a former high official of the Atomic Energy Commission has said of previously published cost figures, that they are "guesstimates." It is my opinion that these figures are excessively high, and that they are so high because they are the result of wrong thinking based on inadequate information.

Our information is inadequate simply because our experience in producing nuclear energy is negligible. We do not have, anywhere in the world, a perfected reactor of any type. Our cost figures are based on installations that were obsolete before they were completed. These cost figures also include expenses properly chargeable to developmental research. The cost of constructing a prototype is ordinarily high, sometimes extremely so, and very often that cost is wholly out of line with the cost of later production models.

Since the data on which our guesstimates of the cost of nuclear power are faulty, we cannot take seriously any conclusion drawn from them as to the cost of erecting a reactor power plant or the cost of the energy it may produce. Of one thing we can be certain: engineering experience will reduce costs, probably sharply.

Let us examine, briefly, how meager is our information on this subject. We know that U235, which is fissionable, occurs in natural uranium in the ratio of seven parts per thousand; and we know that one pound of fissionable uranium is the equivalent of 650 tons of coal.

Most of the world's experience is based on crude reactors that convert only about seven tenths of 1 per cent of their fuel into heat (the actual figure is slightly greater than this because some of the U238 is converted into fissionable plutonium).

We know less about converter-type reactors that are designed to promote conversion of some of the stable U238, which makes up 99.3 per cent of all natural uranium, into plutonium 239. Early indications suggest that the converter type will be about three times as efficient as the crude reactor.

We know still less about the breeder-type reactor, which will produce more fuel than is consumed. Theoretically, when this type of reactor is perfected, we shall be able to obtain one hundred times as much power potential as in the crude uranium reactor.

Of course, all these figures are used only to show the tremendous possibilities that will be ahead of us when the reactors are perfected. They are interesting only in that they show that the cost of fuel in future installations will be purely incidental. In such reactors U235 is employed primarily for the production of neutrons that convert the stable U238 into P239. We have only begun to explore the potentialities of this radical experiment: the creation – not merely the production – of energy. On August 23, 1958, the United States Atomic Energy Commission announced that it had operated in Idaho a reactor with P239 as fuel. The announcement said that the reactor had operated at "substantial power" and that the anticipated capacity of the installation is thirty thousand kilowatts.

These data are only preliminary; many difficulties are still unsolved. For example, plutonium is immensely radioactive; it is difficult to tool and it presents great poison dangers. There are other problems such as the disposal of radioactive wastes and prevention of explosions, but these and other problems are chiefly engineering ones. The history of engineering suggests that inventive and resourceful men will solve them, and will do so in a comparatively short time.

The question now is: with the foregoing facts in mind and, keeping in mind also the inescapable fact that fossil fuels, as they become exhausted, will constantly rise in cost, will nuclear energy prove to be as excessively expensive as the "guesstimaters" have predicted? I believe it will be clear to everyone in a very short time that nuclear energy is the cheapest new energy source in the world today, and that tomorrow, with fusion reactors making available the virtually inexhaustible deuterium supplies of the seas, the cost of nuclear energy will become negligible.

We must not forget that, for the moment, we are using the process of fission only to replace the conventional fuels: in other words, the main part of the present nuclear power plant is the same as that of a conventional installation. We use the heat produced by the reactor to produce steam, and that is why the efficiency is so low. The real value of nuclear energy will become apparent when we shall be able to produce electric current directly from the reactor. There are no theoretical objections to this development, and research necessary to produce a solution is well under way.

The same can be said of the problem of selecting the most efficient reactors. It is not appropriate to discuss, within the scope of this report, the technical aspects of these problems.

Who Needs It?

I have remarked that the United States is less in need of new energy sources than the rest of the world. A number of indices of our relative

wealth could be cited. For the purposes of this discussion, it may be best to employ kilowatt hours as a measure. At the first conference on peacetime uses of atomic energy held at Geneva in 1955, it was revealed that world production of electric energy today is approximately 1500 billion kilowatt hours. Of this amount, 40 per cent – 625 billion kilowatt hours – was produced by the United States, although we constitute somewhat less than 5 per cent of the world's population. Other sections of the world, Western Europe, even the Union of Soviet Socialist Republics, although poor by comparison with the United States, are rich by comparison with many of the truly poor nations, particularly some of those that are only now, under the impetus of ardent – even truculent – nationalism, emerging from colonial status. Many of these are countries whose populations have spurted with the aid of modern medicines and insecticides. A generation or two ago, moderate improvements in their agriculture or industry would have meant prosperity, progress, and peaceful evolution. Today, in such countries, the production of mouths outruns the benefits obtained from irrigation and hydroelectric installations. Most of these countries have no fossil fuel resources. Nevertheless, they seek and demand political and economic autonomy. Their demands can be met only by providing their peoples quickly with relatively high levels of energy. The report of the Geneva conference of 1955 set six thousand billion kilowatt hours as the probable production of electric power in 1975. This is four times the 1955 rate. Even if this amount of power could be produced from fossil fuels and hydroelectric installations, with our present methods it could not be transported to the hinterlands of the impoverished nations where it is most needed.

We may well repeat here that this great discovery of nuclear energy is taking place at the very moment it is needed. Nuclear power plants do not depend on altitude or water supply. They are independent of railroad or ship transport and of longitude or latitude. Once established, they do not call for a continuous daily supply of fuel. Furthermore, and this is very important in regions where the number of trained engineers is limited, a nuclear reactor runs almost automatically and does not call for a large operating staff. Nuclear energy is, in fact, the only potential power source that meets all the requirements of this exigent moment in world affairs. History shows that the hungry and the wronged attempt to better their condition by violence, but that prosperous and happy men effect what may be truly revolutionary changes by peaceful means. Nuclear reactors will bring the promise of peaceful aggrandizement to the have-not nations of the undeveloped sections of the world.

This source of power bears a similar promise for Western Europe, a region that is highly developed, but one that is virtually without petroleum and faces the prospect of inadequate coal supplies. Actually, coal production in continental Europe has only now reached the prewar 1937 level after years of intensive effort. The United Kingdom's production of coal

for the last 10 years has oscillated between 225 and 250 million tons per year, and there is no hope of increasing this tonnage. Not more than 60 per cent of Western Europe's present fuel requirements are being met with coal. The deficit is being made up with oil, chiefly from the Middle East. Sixty per cent of the world's petroleum supply lies in that area, and continued delivery to Europe is not assured.

One need only recall the recent crisis, not yet resolved, that closed the Suez Canal and various pipeline routes for the transport of oil from the Middle East to Europe to recognize how uncertain these supplies are. Moreover, even if this oil were to remain available to Europe, the fact remains that it is exhaustible. More important still is the consideration that, like all other fossil fuel supplies, it is irreplaceable. Since oil and coal are of far greater value as petrochemicals than as fuel, it will be inexcusably wasteful to use them to produce power when nuclear plants can assume the task of generating electricity.

It must be kept in mind that this is the only function of a traditional power plant that will be taken over by nuclear fuels. Except for the replacement of fossil fuels by nuclear ones, no adaptation will be required. Production of electric energy directly from the reactor, although beyond our capacities at the moment, is certain to come in the future. Even then, however, our present systems of distribution will probably remain largely unchanged.

The English have been the first to realize their need for atomic power, and they have built a number of reactors, some of them on an industrial scale. They report that the cost of electricity produced by nuclear fuel is already comparable to that of electricity produced by conventional installations. Of course, the cost of electricity from fossil fuels is highly variable, depending on the availability of fuel and other factors. The British plants, using crude uranium as fuel, appear to be sufficiently efficient to produce in competition with fossil-fuel plants in areas of high cost. England is already engaged in a promising export business, bidding on the erection of natural uranium reactors in Italy, Japan, and possibly other countries. The same sort of development is taking place in France, which has erected a number of reactors, some of which are also on an industrial scale. At the second international conference on peacetime uses of atomic energy held in Geneva, Switzerland, in 1958, the French also announced the construction of a plant to separate U235 from U238.

Euratom, which will receive an important quantity of enriched uranium from the United States, is initiating a large program of erection of industrial reactors in the near future, and there is evidence that other Western European nations are alert to the potentialities of nuclear energy.

The status of nuclear energy in the United States reflects our comparative wealth rather than thoughtful foresight. Until recently the policy of the Atomic Energy Commission has been expressed *grosso modo* as

follows: the United States is a very rich country with great resources in fossil fuels and with great hydroelectric potentials still unexploited. There is, therefore, no urgent need to begin constructing nuclear power reactors immediately. Plants we build now will inevitably reflect our lack of engineering information. They will be too expensive to compete with fuel—or with water-produced power. Therefore, let us wait. Let us investigate. Let us determine just which type of reactor will be most efficient. Then, when all the preliminary spade work has been done, carefully and methodically, after all the necessary preliminary tests have been completed, we shall proceed with a large program of nuclear power production.

However, there seems to be a change in the trend outlined. The General Electric Company has recently proposed the immediate construction of a series of reactors throughout the nation. Lately, in one of his public appearances, Commissioner Willard F. Libby mentioned that the Atomic Energy Commission now is developing the construction of a dual reactor, producing power and plutonium, in order to evaluate its usefulness.

It is interesting at this juncture to note that the United States is still the only nation able to produce in quantity the enriched uranium fuel required by advanced types of reactors.

Recently, Walter H. Zinn, in his report to the Joint Congressional Committee on Atomic Energy, made a thorough appraisal of Soviet atomic power developments. He is deeply impressed by the fact that Soviet technical progress is rapid and closely coordinated with the program of building intermediate and large-size reactors. As is the United States, the Soviet Union is experimenting with several different types of reactors, but has a definite policy of rapid "scale-up," with reactor types first built as 50,000 kw plants, followed by large-scale power stations with capacities as high as 600,000 kw.

During the second world conference on peacetime uses of atomic energy, the Soviets showed a film representing a large plant of 600,000 kw located somewhere in Siberia. This plant produced plutonium and power.

The first question that always arises is, are we or the Soviets ahead in the development of reactors? The question may be natural, but the answer is more complex than it seems at first glance. We are not witnessing horse races where the winner is apparent. In such complicated engineering development, sometimes a new "know-how" may favor a competitor with a great advance. It is sufficient to state simply that the Soviets are in a well-advanced stage of development and construction of power plants in comparison with anyone else.

I was present at the second world conference in Geneva and I fully agree with Zinn's opinion.

What Will Be The Effects?

The great upward surge of the world's population now taking place, which makes the development of nuclear energy an immediate and urgent necessity, will be sustained by it. This foreseeable increase in the numbers of men will be accompanied by perhaps less predictable but no less certain changes in economics affecting both capital and labor. These changes will require alterations in education and in social and cultural activities.

Increased population. This factor will make it necessary for large populations to live in regions now but sparsely populated. Cheap nuclear power will make this population shift possible.

The exigencies of manufacturing or communication by sea and rail which, throughout history, have determined concentrations of population – as in the Ruhr, London, New York, and nearby seaboard cities – will no longer be decisive factors. In the future, new communities will tend to be relatively small and uniform in size. This is one of the best prognostics for the future. There is no doubt that, if the big cities of today were to continue to expand and the new industrial revolution were to keep its present pace, we could expect social disorder and, inevitably, a government of dictatorial type.

The only solution is the gradual dissolution of these centers and the establishment of homogeneous, smaller communities, built around nuclear reactors. These communities will necessarily consist of technically educated or re-educated citizens capable of useful work. A satisfied, well-paid, and homogeneous community is less susceptible to extremist influences and offers the best assurance of perpetuating democracy. Such a community may well be self-sufficient or a one-product, one-activity grouping as part of a general plan.

Government capital. As regards the energy source, federal ownership and operation are inevitable. This development has been anticipated by government ownership of hydroelectric plants, a phenomenon that has grown along with such plants since 1910, when they first became an important factor in the generation of electric power. By contrast, conventional fuel-using plants are comparatively inexpensive to construct and, in the United States, they have usually been built with private funds. Nuclear power plants will be expensive because their fuel constitutes a large part of the initial investment. Only small additional quantities of fuel will be needed from time to time to replace the used part of the initial load. This nuclear fuel is, and will remain, a government monopoly. However, this explains only partly why government must provide capital for nuclear plants. Other reasons are that there is not enough private capital available to finance such plants and, by contrast, there is too much risk. The earning capacity of early plants in the United States will be uncertain. The final and definitive reason government must finance nuclear installations is that their development is of para-

mount importance to the national economy and defense. Consequently, there is every reason to assimilate such government investments into future military appropriations. Under no circumstances should they be regarded as income-producing investments.

For the long term, exactly the opposite situation may be considered as a possible development, and reactors could quite properly support the government. It is interesting to speculate about this potentiality. Suppose, for instance, that taxation as we now know it in all its incredible complexity were eliminated and nuclear-fuel rent were to be substituted. If rents paid for nuclear fuel were to become the sole source of government income, tax bookkeeping and related problems of both government and industry would be vastly simplified – and the individual taxpayer's lot made much more pleasant.

Technological unemployment. This factor will wipe out entire strata of labor. Those to suffer most will be the so-called specialized workers, many of whom will disappear to join the masses of unskilled or to be re-educated for technical employment. This trend is natural and irreversible. Already we see the process at work as automation advances, with machines taking over the work of men's hands and minds as it originally took over the handling of dangerously radioactive materials in our first nuclear reactors. Increasingly, we see fewer and fewer workers on the production lines. Authorities predict that our industrial installations soon will resemble electric power plants, great halls with automatic machines aligned in functional patterns with only a few supervisors checking dials and lights. Electronic brains are replacing men in banks, insurance firms, and in other commercial establishments calling for extensive calculations. The same displacement is going on in research and development, in road building, and in other construction.

This aspect of the new industrial revolution is only in its infancy. Even so, already we are witnessing the impact of obsolete science on automation machinery as massive machines employing vacuum tubes are replaced by smaller devices using transistors. Electronic devices have not yet assumed control of production, but we are developing more competent machines that will take over the human function of supervision, of catching and correcting mistakes. It is altogether possible that, in the future, we shall be able to construct machines that can think, learn, grow, and make duplicates of themselves with built-in instructions to do the same useful work. The process could continue indefinitely.

In a man of the Nineteenth Century this concept would inspire unreasoning terror. In a man of the mid-Twentieth Century it should inspire informed concern.

I address myself hereafter to the possibilities of a future of abundant energy, of which automation is merely the aspect most clearly visible.

I speak not as a sociologist, or economist, or educator, or political scientist, but as an engineer. I propose to extrapolate, as accurately as

I can from the evidence now available, the major implications of the exploitation of nuclear power.

Up to this moment, man's whole history has been lived under the shadow of scarcity, of insufficient food, of inadequate shelter. This scarcity has been a measure of the availability of energy. Even the present relative abundance in the United States has not meant sufficient food or adequate shelter for those of our people at the bottom of the socioeconomic ladder. We still retain in our vocabulary the phrase "poverty-stricken," and all understand its connotations. How many of us have used the phrase "leisure-stricken" or given thought to its implications?

Leisure will soon be one of the major problems with which individuals, families, and governments will be faced. The average industrial work week will probably very soon be no more than twenty hours. In the not distant future, it may very well be less. What kind of problems will this create?

We can see at once that the problems of leisure will be different for different types of persons in different environments.

In the cities, which are already becoming atavistic anachronisms, our chief concern, perhaps, should be with those classes of workers who are to be displaced by automation: the production workers with specialized skills and the clerical workers whose jobs will be taken over by machines. In the city of New York alone there are several hundred thousand such potential "displaced persons." With their jobs gone, deprived of status, their earning power depreciated or lost entirely, these people will be downgraded to the status of unskilled labor, the most dangerous and explosive segment of society. They will become susceptible to the incitement of irresponsible agitators, or to their own baser impulses. Unless we wish to see violence, crime, and vice increase, we must find ways to forestall these undesirable results of the transition to a nuclear-powered industry. Retraining these displaced specialists will be imperative.

A part of the solution that I, as an engineer, can see is the development of relatively small communities centered around a nuclear power plant. These communities will be inhabited primarily by specialists and their families. In the beginning, of course, many of the industrial workers will be retrained specialists from former semiautomatic manufacturing plants. These two factors – few and useful, adequately paid employees – will assure social stability in the reactor-centered communities of the future.

However, the acquisition of new skills, new jobs, and new homes will not solve all the problems of the leisure-stricken, who will still be faced with the threat of boredom. Our people, particularly the present generation, have not been prepared through education or culture to spend leisure in a socially desirable or dignified manner.

We can predict with relative accuracy what use will be made of the goods an economy of abundance will provide for us. We cannot so readily predict the uses to which the new leisure will be put. This will be a problem for all segments of society, individuals, families, and governments. Culture cannot bear the initial burden of preparing us for leisure. Our culture has valued money more than music, industry more than art, food more than pleasure, labor more than leisure. This, incidentally, is a good example of the way in which technical developments outrun social progress. Because our resources of entertainment are so grievously insufficient to accommodate the needs of a growing number of the leisure-stricken, it will certainly become a responsibility of government to educate our people to use their free time constructively. The choice is clear, but we must act immediately. It will not be easy to educate large masses of people in one lifetime, or one generation, and, I fear, this is all the time we have. It is a problem that should be faced now, with courage and initiative, lest the tremendous new energies we are about to unleash be turned ignorantly against us.

Thus far we have considered only the impact of nuclear energy on industry. It must be noted that agriculture also will be affected. In the last century, in the United States, first automatic machinery, as in the reaper and thresher, made it possible to substitute the energy of draft animals for human effort; then steam power supplanted horses, especially in threshing in the great grain-producing lands of the West. In the last generation or two, internal combustion engines have all but completely replaced draft animals in the field and, with electric power in barn and farmstead, have made it possible for a single man to do the work of five or more. A century ago, 85 per cent of our population lived on the land; today fewer than 15 per cent produce all the food required by our people and constantly pile up surpluses. In the same century, particularly in the latter half of it, new advances in biology have given us more viable, more productive food, fiber plants, and meat and dairy animals. The cultivation of algae, still in the laboratory stage, promises virtually unlimited food supplies for the future. Today at the Brookhaven National Laboratory for Nuclear Research, Brookhaven, N. Y., mutations are being induced in food plants that will further improve our agricultural production. In the future, wide distribution of reactors will expedite the use of nuclear energy in agriculture. Indeed, the prospects for the production of food in the future are so excellent that, when they are clearly seen, they will put a stop to specious philosophizing about the necessity to limit and and regulate the reproductivity of man.

The unpleasant fact remains, however, that although famine is no threat to the United States, it is a continuing and increasing danger in some of the less fortunate nations. The energy supplies available in the world today are sufficient to provide for every inhabitant of the globe the minimum necessities of food, clothing, and shelter. That poverty and

famine any longer exist anywhere is the result of defective and obsolete systems of distribution. The turmoil of the emergent nations and the spiritual distress of the West, the anxiety we exhibit, the gloom we feel, can be attributed, I suggest, to our failure to develop in the social field techniques as advanced as those adopted in scientific areas. Distribution of wealth is essentially a social mechanism.

Until the last few years, we lived in a world where the distribution of food, clothing, and shelter was governed by a railroad timetable. Today we live in a world of jet airliners. We are unhappy with our performance because we lack the courage to act *as if* we lived in a jet age. We cling, instead, to the railroad tracks and the slow schedule of the past. We must abandon the past and embrace the future. Technically, we have moved into the Twenty-First Century; we cannot afford longer to cling to Nineteenth-Century thinking – that of the era of the railroad. This is, of course, a problem for statesmen, economists, sociologists. As an engineer I feel impelled, however, to point out that distribution of essentials is a world problem and requires a worldwide solution. Lend-Lease, the Marshall Plan, Point Four, all the piecemeal plans are mere stopgaps. They cannot solve the entire problem.

As a matter of fact, again citing only the apparent need and not attempting to specify the solution, it should be pointed out that worldwide availability of nuclear energy will make necessary, not only worldwide distribution, but a world plan for production. If some countries, such as the United States, can produce and fabricate steel more advantageously than others, why should Japan or China build steel mills? Perhaps India should concentrate on fibers, Canada on cellulose, Argentina on beef; why should England allocate limited acres to raising cattle, or Egypt undertake to produce aluminum? The new world of abundance will be, inescapably, one world.

The scientists who have made this one world possible, who have made it inevitable, have perceived this truth. They are men who were educated chiefly in schools and universities in which the old concepts of an economy of scarcity and a world divided were accepted as unchanging truths hallowed by ages. The fact that the scientists could change not only their minds, but their hearts, leads me to expect and hope that similar changes can be brought about in the thinking of statesmen. One of them, Wendell Wilkie, saw the light fourteen years ago. "One world – or none," he said then. The truth of that statement grows more evident every year.

I must say here that I do not believe that our choice will be "or none." I believe mankind will survive, that there will be no nuclear war. The masses of the world fear nuclear destruction. The beneficial aspects of the new discoveries are less apparent to them, especially because many of the applications of nuclear energy are so complex technically, and their implications so revolutionary, that it is difficult for the common

man to grasp them. Therefore, it becomes the duty of the scientific community, the press, and other communications media to bring to the masses a fuller understanding of the good life that lies before us. This, also, must be done on a global scale.

Along with an understanding of the promise the future holds, the world's peoples must be warned of the trials that are certain to accompany our transition from an economy of scarcity to one of abundance. Some of these troubles will seem, at the time, all but unbearable. Men and governments will be tempted to resort to violence to hasten the advent of the promised future – or to block the social and economic changes inherent in it. Small wars, insurrections, and local turmoil can delay the time when all will share abundance. The process of transition may be thus made painful and prolonged. To accelerate and make it less onerous, the scientific community should undertake to assist those to whom are entrusted our state and social institutions to bridge the gap in the easiest and most successful ways, avoiding social unrest and armed conflicts.

I am certain that United States scientists and their colleagues elsewhere will succeed in the immense task that lies before them.

SECTION OF PHYSICS AND CHEMISTRY

DIFFUSION STUDIES OF SOME METALLIC IONS IN A POLYELECTROLYTE SOLUTION*

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Polyelectrolytes, which are both polymers and electrolytes, have certain properties that are different from those of ordinary polymers and those of nonpolymeric ions. These properties are associated with a high charge density that, in turn, arises because the ionizable groups are forced (by their covalent binding) to remain in close proximity to each other. There is as yet no completely satisfactory theory that explains the behavior of polyelectrolyte solutions. There is general agreement, however, about a qualitative picture of this behavior.[1-4] The polyelectrolyte is regarded as a region of high-charge density in the solution. The counter ions are grouped about them in a distribution described by a Poisson-Boltzmann function. Thus, the counter ions would have a relatively high concentration in and around the polyion volume, gradually decreasing with distance. Wall and his co-workers[5] have simplified this picture further by dividing the counter ions into two groups: (1) those that move with the polyion, called bound, and (2) those that move more or less independently of it, called free. While this is an oversimplified picture, it permits some treatment of experimental data.

The first section of this paper describes some of the work of James Dux,[6,7] who studied the diffusion of strontium ion at 25° C. in solutions of polystyrene sulfonic acid. This acid was prepared by sulfonating 2 types of polystyrene: a low molecular weight material ($\overline{M}_w$=1230) and a higher molecular weight polymer ($\overline{M}_w$=33,000). Sulfonation was performed by either hot concentrated sulfuric acid or by SO_3 in a chlorinated solvent. The degree of sulfonation was approximately 1 per benzene ring. The diffusion measurements were made by the technique originated by Anderson and Saddington.[8] Restricted diffusion of a radioactive tracer takes place out of a solution in an open-ended capillary into a large reservoir filled with a nonradioactive but otherwise identical solution. If the solutions have inactive isotopes of the tracer at concentrations large compared to that of the tracer, the coefficient is called the self-diffusion coefficient. If only the radioactive tracer is present, at very low concentration, the coefficient is known as the tracer diffusion coefficient. The solutions consisted of a polystyrene sulfonic acid (whose concentration of sulfonic acid monomer was approximately 10^{-4} *M*) and varying proportions of strontium, added as the hydroxide. The radioactive

*This paper, illustrated with slides, was presented at a meeting of the Section on December 2, 1958.

tracer was Sr^{90}. The tracer diffusion of Sr^{90} was first measured in HCl and in H_2SO_4 solutions, yielding values at 25° C. that approached 0.7×10^{-5} cm.^{2}/sec. in dilute acid. This value compares favorably with the theoretical limiting value of the coefficient from the Nernst equation, which is 0.796×10^{-5}.

In treating the results of the diffusion of strontium in the polyacid solutions, it was assumed that the rate of exchange between the free and bound strontium ions was much more rapid than the diffusion rate of either type.[1,3,9] This led to the equation[6]

$$D = f_A D_A + f_P D_P \qquad (1)$$

in which D is the measured self-diffusion coefficient, D_A the coefficient of the free ions, D_P the weighted mean diffusion coefficient of the bound counterions, f_A the fraction of strontium that is free, and f_P that of the bound strontium. One consequence of this equation is that the measured diffusion coefficient should be independent of the time of diffusion. This is shown to be the case in TABLE 1. In these experiments the high

TABLE 1

STRONTIUM SELF-DIFFUSION COEFFICIENTS IN POLYACID SOLUTIONS AS A FUNCTION OF TIME

Time of diffusion (hours)	$D\times10^5$, cm.^{2}/sec.	
	High mol. wt.	*Low mol. wt.*
43	0.518 ± 0.033	–
67	0.525 ± 0.024	0.519 ± 0.024
90	–	0.536 ± 0.008
91	0.516 ± 0.026	–
115	–	0.551 ± 0.022
139	0.526 ± 0.043	–

molecular weight material was 43 per cent neutralized by strontium hydroxide, and the low molecular weight polymer was 58.2 per cent neutralized.

The tracer diffusion coefficient of strontium at 25° C. in solutions of polystyrene sulfonic acid (10^{-4} *M* in sulfonate) was also measured. In these experiments, Sr^{90} was dissolved in the solution at a concentration of 10^{-8} *M* or less, and hence was present to an extent that was negligible compared to other electrolytes. Onsager[10] has shown that in such a case both electrophoretic and diffusion potential effects can be ignored.

TABLE 2 shows the tracer diffusion of strontium in a solution of the low molecular weight polystyrene sulfonic acid, measured for different periods of time.

Similar results were obtained with the material of high molecular weight. The effects were interpreted as an irreversible binding of strontium to the polyelectrolyte, or else as a very slow exchange between bound and free strontium. If exchange is very slow, then free strontium ions will diffuse out first, followed by strontium bound to low molecular weight polyions and, finally, the strontium bound to the larger polyions. This will result in a diffusion coefficient whose value will decrease as the time of diffusion is increased.

TABLE 2

TRACER DIFFUSION COEFFICIENTS OF STRONTIUM IN POLYSTYRENE SULFONIC ACID SOLUTION (LOW MOLECULAR WEIGHT)

Time (hours)	$D \times 10^5$, *cm.*^{2}*/sec.*
67.0	0.528 ± 0.032
91.0	0.504 ± 0.007
115.0	0.472 ± 0.011
163.0	0.411 ± 0.013

The tracer diffusion was investigated further by preparing a low molecular weight polystyrene of narrow range by fractional precipitation, and then sulfonating it with radioactive SO_3. The solution from which the capillary was filled contained polystyrene sulfonic acid tagged with S^{35}, as well as Sr^{90}. The external solution contained nonradioactive polystyrene sulfonic acid prepared from the same polystyrene fraction and sulfonated under similar conditions. The sulfonic acid (monomer) concentration was the same in each (8.63×10^{-4} *M*). The electron emitted by sulfur-35 is very soft compared to that emitted by yttrium-90 (the daughter of strontium-90). It was found that a 0.08 mm. thickness of aluminum would reduce the activity of sulfur-35 to about one half per cent of its initial value, whereas the activity of a strontium-yttrium sample was reduced to 76 per cent of its original value. Hence, by measuring the activities of a sample with and without such an aluminum absorber, it was possible to calculate both the self-diffusion of the sulfonated polymer and the tracer diffusion of the strontium. The results The results are shown in TABLE 3.

These results are interpreted in the following way: the strontium is bound to the polyelectrolyte. The latter, because of its narrow molecular weight distribution, shows no decrease in diffusion coefficient with increasing time. Second, the sulfonated polymer is contaminated with an impurity also containing S^{35}. The latter diffuses out first, followed by the polymer itself. A mathematical analysis of the results[7] shows that such an impurity would have a diffusion coefficient that is practically the same as that for sulfate ion. Hence, the impurity was probably sulfuric

TABLE 3

SELF-DIFFUSION OF S-35 TAGGED POLYMER AND TRACER DIFFUSION OF Sr-90

Time (hours)	$D \times 10^5$, cm.^{2}/sec.	
	Sr-90	*S-35*
67.2	0.373 ± 0.014	0.684 ± 0.009
91.0	0.375 ± 0.007	0.505 ± 0.026
112.0	0.386 ± 0.030	0.422 ± 0.036

acid that was not removed completely by the ion-exchange treatment used for purification. It was concluded that in the limit the strontium and the sulfur would show the same diffusion coefficient and, therefore, that the strontium was bound to the polymer and diffused with it.

Tracer diffusion coefficients were run in similar fashion for sodium and cesium. The results are shown in TABLE 4. D_o refers to the limiting ionic coefficient.

It is clear that, in contrast to strontium, the alkali ions show no binding at the tracer level.

Edward Hardy [11] has made a number of tracer-diffusion measurements of strontium in solutions of Lustrex X-710, which is a Monsanto sulfonated polystyrene prepared from a resin having a molecular weight range of

TABLE 4

TRACER DIFFUSION COEFFICIENTS OF Na^{24}, Cs^{137}, AND Sr^{90} IN POLYACID SOLUTION (LOW MOLECULAR WEIGHT)

Ion	*Time (hours)*	$D \times 10^5$, cm.^{2}/sec.	$D_o \times 10^5$, cm.^{2}/sec.
Na	67	1.43 ± 0.03	1.33
Cs	67	1.89 ± 0.26	2.08
Sr	67	0.53 ± 0.03	0.796

8,000 to 12,000. This compound was converted to the sulfonic acid form, and tracer diffusion coefficients of Sr^{90} were measured at 25° C. in solutions that were 10^{-4} *M* in sulfonic acid. TABLE 5 shows the results obtained for different times of diffusion.

The same effect found by Dux is evident here: the tracer diffusion coefficient decreases with time of diffusion. The difference is that the values in this table are markedly lower than those reported earlier. This probably arises from the presence of many low molecular weight fragments in the earlier samples, and the narrow molecular weight range of the Lustrex.

TABLE 5

TRACER DIFFUSION OF STRONTIUM IN ACIDIFIED LUSTREX X-710 SOLUTION

Time (hours)	$D \times 10^5$, cm.^{2}/sec.
41	0.216 ± 0.028
52	0.171 ± 0.014
69	0.122 ± 0.028
72	0.100 ± 0.009
110	0.106 ± 0.012

The effect of added $SrCl_2$ on the diffusion coefficient of bound strontium is shown in TABLE 6. The reversibility of the system was demonstrated by adding Sr-90 (10^{-8} *M*) to the polyacid solution, allowing it to equilibrate, and then adding 10^{-5} *M* $SrCl_2$. Essentially the same value of the self-diffusion coefficient was obtained by equilibrating polyacid with 10^{-5} *M* $SrCl_2$, and then adding the radioactive tracer.

TABLE 6

EFFECT OF ADDED $SrCl_2$ ON THE DIFFUSION OF STRONTIUM IN POLYSTYRENE SULFONIC ACID SOLUTION

Added $SrCl_2$ (M/l.)	*Time (hours)*	$D \times 10^5$, cm.^{2}/sec.
0	72	0.100 ± 0.009
10^{-7}	70	0.136 ± 0.046
10^{-6}	70	0.147 ± 0.019
10^{-5}	70	0.137 ± 0.015
—	71	0.183 ± 0.016
2×10^{-5}	70.3	0.400 ± 0.039
3×10^{-5}	69	0.444 ± 0.043
4×10^{-5}	69.3	0.518 ± 0.024
5×10^{-5}	66.1	0.668 ± 0.077
10^{-4}	73.3	0.728 ± 0.012

These results show that there is strong binding of strontium by the polymer up to a strontium concentration of 10^{-5} *M* (equivalent to 20 per cent of the sulfonic acid sites). Further increase in strontium chloride concentration results in exchange between bound and free strontium, and a decrease in the fraction that is bound. In the presence of an excess of strontium, very little of it, if any, appears to be bound.

There are several areas of application of these phenomena. In one direction, if one finds an ion at the tracer level that is very strongly

taken up by the polyelectrolyte and that is difficult to displace, then in effect the polyelectrolyte is tagged. At the other extreme, it is possible to find a use for an ion that is not bound at all. Abraham Saifer has been studying the binding of ions to proteins, and has utilized unbound ions for the purpose. One of the methods of studying ion binding to proteins involves equilibrium dialysis through a membrane impermeable to proteins, but not to simple ions. The difference in concentration of a given ion inside the membrane (with protein) and outside the membrane (without protein) permits the calculation of the number of ions bound to the protein, if suitable corrections are made. However, the suitable corrections involve either a determination of the Donnan ratio[12] at low concentrations or a swamping-out of the Donnan effect by using high concentrations of buffers and other electrolytes.[13] The latter technique introduces ions that compete with the ion of interest for the sites on the protein. Hence, in dilute solutions (dilute to minimize binding competition) the Donnan ratio must be evaluated. It can be evaluated if one introduces an ion that is known not to be bound to the protein under the conditions of the experiment. The ratio of concentrations of such an ion inside and outside the membrane will yield the Donnan ratio for all similarly charged ions in the system. For a simple polyelectrolyte, such as polystyrene sulfonic acid, an ion such as chloride very obviously will not be bound, and it can be used to determine cation binding. For a protein, the choice is more difficult. Since Dux found that sodium at low concentration did not bind to the sulfonate polyions and since Scatchard and his co-workers[4] by E.M.F. measurements have reported that sodium does not bind appreciably to albumin up to 10^{-4} *M*, Na^{24} was selected as an indicator ion in studying the binding of iodide to various albumins. Preliminary diffusion measurements show that it is not appreciably bound to bovine serum albumin. The radioactive sodium was added to a solution of bovine serum mercaptalbumin (2 to 4 per cent), to which was added radioactive iodide (I^{131}) and enough inactive sodium iodide to raise the total iodide concentration to a desired level. After dialysis had reached equilibrium, the combined sodium and iodide activities were determined in each compartment. After the sodium had decayed, the iodide activity was measured and the sodium was determined by difference. If the sodium is not bound, then:

$$I^- \text{ (inside total)} = I^- \text{ (inside bound)} + I^- \text{ (inside free)} \tag{2}$$

$$I^- \text{ (inside free)} = I^- \text{ (outside)} \times \frac{Na^+ \text{ (outside)}}{Na^+ \text{ (inside)}} \tag{3}$$

$$I^- \text{ (inside bound)} = I^- \text{ (inside total)} - I^- \text{ (outside)} \times \frac{Na^+ \text{ (outside)}}{Na^+ \text{ (inside)}} \tag{4}$$

TABLE 7 shows a number of such determinations of iodide binding to BSM at different iodide concentrations, compared with similar determi-

TABLE 7

COMPARISON OF IODIDE-ION BINDING TO BOVINE SERUM MERCAPTALBUMIN BY E.M.F. AND EQUILIBRIUM DIALYSIS METHODS

$[I^-]$ (M/l.)	$\frac{\text{moles } I^- \text{ bound}}{\text{mole protein}}\left(\text{Dialysis method}\right)$	$\frac{\text{moles } I^- \text{ bound}}{\text{mole protein}}\left(\text{E.M.F. method}\right)$
5.1×10^{-3}	4.86	4.50
2.7×10^{-3}	3.71	3.00
1.0×10^{-3}	2.30	1.80
1.6×10^{-3}	2.09	1.30
3.1×10^{-4}	0.86	0.80

nations made by Scatchard and his co-workers[15] on the same protein, using E.M.F. measurements. It appears that the agreement is fairly good.

Acknowledgment

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SECTION OF BIOLOGY
and
DIVISION OF MYCOLOGY

VIRUSES IN TISSUE CULTURE

I. PLANT VIRUSES IN TISSUE CULTURE*

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Great advances in our knowledge of the viruses of man and animals have resulted from the fact that it is comparatively easy to infect animal cells and tissues and to study virus multiplication in cell and tissue cultures. Only two attempts to infect plant tissue cultures with viruses were published in the older literature (Segretain, 1943; Morel, 1948). Very recently Kassanis *et al.* (1958) and Hildebrandt (1958) also have reported the infection of plant tissue cultures. This paper describes similar experiments carried out in Tübingen at the Max Planck Institut für Biologie during the last two years.

Infection of Isolated Tomato Roots in Culture

In 1934 P. R. White isolated and grew in culture roots from tobacco mosaic-infected tomato plants. He found that they remained infective in culture and that there was no difference in the growth of virus-infected roots and of virus-free roots. However, White could not compare roots from the same origin because he could not infect isolated roots with virus. He compared only different root strains, one derived from an infected tomato plant, the other from a noninfected plant. My associates and I were interested in obtaining a virus-infected and a noninfected strain of the same origin, and we tried therefore to inoculate isolated roots *in vitro*.

This was achieved in the following manner: root tips about 3 to 5 cm. long were placed in Petri dishes and rolled back and forth with a spatula in a suspension of fine quartz powder containing tobacco mosaic virus. Then the roots were removed to flasks with fresh nutrient and allowed to grow. The sterile virus suspension for the infection was prepared from stem segments cut out of systemically infected tobacco plants *(Nicotiana tabacum* var. "Samsun") under sterile conditions, or from tobacco tissue cultures infected with tobacco mosaic virus. In later experiments we

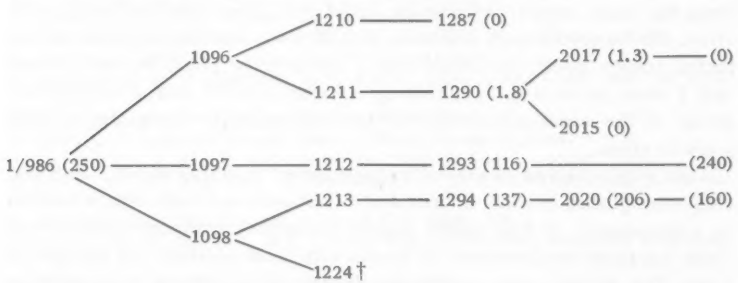
*This paper, illustrated with slides, was the first of three papers presented at a joint meeting of the Section of Biology and the Division of Mycology on December 8, 1958.

found that we also could use virus preparations sterilized by filtration through a sterile bacterial filter (Schott Glasfilter). After 2 weeks each root was subcultured and a sample tested for virus infectivity by inoculating leaves of *Nicotiana glutinosa* with homogenates of the roots. We learned in our experiments not to make too many or too large wounds because the roots then died; on the other hand, we had to make enough wounds to get an infection. By testing the virus content of the roots we found two groups distinguished by their virus content. One group contained large amounts of virus and gave from 200 to 300 lesions per leaf on *Nicotiana glutinosa*, while the other group had only a small amount of virus and gave about 10 lesions per leaf. Permanently infected roots were obtained only from among those that showed a great number of lesions. The same finding was made by Kassanis *et al.* (1958), who also tried to infect tomato roots with virus and obtained roots with either heavy or weak infection.

We found further that the virus content of the roots in the first passages was not constant. In some cases some of the subcultured roots lost the virus. This is explained in TABLE 1. Subcultures were made from root number 1/986, which gave 250 lesions per leaf. After 3 passages, the virus content in some roots was either low or absent. During the next passages all subcultures from these roots lost the virus. During a cultivation period of about 2 years subcultures of the 2 other lines derived from roots number 1097 and 1098 never lost their virus content.

TABLE 1

VIRUS CONTENT OF SUBCULTURES OF AN EXCISED TOMATO ROOT INFECTED WITH TOBACCO MOSAIC VIRUS *in Vitro*



Our experiments showed clearly that it was possible to inoculate tomato roots with tobacco mosaic virus and to obtain permanent infection of roots. A multiplication of tobacco mosaic virus soon after inoculation was also observed by White in his experiments, but he did not succeed

in getting permanently infected roots. It seems likely that the roots in his experiments in which there was very little multiplication of virus were comparable to the roots in our experiments that yielded only small numbers of lesions when tested. I conclude from our experiments that the virus in the isolated roots either did not move or moved only very slowly; therefore, roots could lose the virus when the growth rate of the root tip was faster than the movement of virus. This conclusion is also supported by the calculations of Uppal (1934) and of Rappaport and Wildman (1957), who found that the spread of tobacco mosaic virus in parenchymatic tissues is approximately of the order of 0.01 mm./hour. The average growth of isolated tomato roots is of the order of 0.2 to 0.5 mm./hour. I assume therefore that only those roots became permanently infected in which cells in or near the meristematic zone were infected with virus.

With subcultures of roots derived from a single root we could confirm the finding of White that virus-infected and virus-free roots grow at the same rate. This lack of difference between rate of growth of roots with or without virus is shown in TABLE 2. The virus content of roots in

TABLE 2

COMPARISON OF GROWTH OF VIRUS-INFECTED AND NONINFECTED TOMATO ROOTS: AVERAGE DRY WEIGHT OF 20 ROOTS

	+ *virus*	− *virus*
June 12 to 26, 1957	10.7 ± 3.6	10.6 ± 3.5
July 2 to 16, 1957	10.3 ± 2.9	11.1 ± 2.0
July 24 to Aug. 6, 1957	9.5 ± 2.4	8.6 ± 2.4
Aug. 20 to Sept. 3, 1957	9.4 ± 2.4	9.4 ± 2.6
Oct. 16 to Oct. 30, 1957	11.4 ± 4.0	10.2 ± 2.9

these experiments was as high as 2 per cent of the dry weight. It is surprising that this surplus did not affect the size of the roots, but there are some indications that the meristematic cells in the root tip are free from virus (White, 1943; Kerling, 1957). If this should be proved, the equal growth of infected and noninfected roots would easily be explained, since the production of intercellular nucleic acid and the synthesis of virus nucleic acid would take place in different cells.

This assumption does not contradict what was said earlier about the infection of the whole root. The growth rate of 0.5 mm./hour of the roots does not mean that all the cells of the meristematic zone and adjacent tissues grow with the same speed. On the contrary, each cell in the root after dividing has its own period of fast growth and elongation, so that the spaces in the root tip at the beginning of this period are small and the virus can move readily from one cell to another.

Chemotherapy

Virus-infected and noninfected root lines were used to test the possible influence of chemotherapeutic agents on virus production and on the growth of the roots. This problem has been discussed in detail elsewhere (Melchers and Bergmann, 1957; Bergmann, 1958) and will be mentioned here only briefly. Many earlier investigations on chemotherapy of plant virus diseases using isolated leaves or leaf discs had one weak point: there was no exact measurement of the action on the host cell. We thought it important to know the effect on the host cell and, at the same time, the effect on the virus synthesis because an effect on the virus multiplication may be obscured by damage done to cells of the host. Therefore, in our experiments the growth of the roots was used as a measure of any possible effect on the host cell.

Two substances were examined that inhibit virus synthesis in plants: (1) the pyrimidine analogue thiouracil, first shown by Commoner and Mercer (1951) to inhibit the production of tobacco mosaic virus in tobacco leaf discs; and (2) the antibiotic cytovirin which, according to a recent report by Gray (1957), reduces the multiplication of southern bean mosiac virus and tobacco mosaic virus in plants. This finding was confirmed by Wittmann (1958) at our institute in Tübingen.

The technique used in our experiments was the following: roots were allowed to grow for 14 days in the presence of different amounts of the tested substances. Then the roots were harvested, dried in a desiccator, and weighed. After the dry weight was measured, the virus content was determined spectrophotometrically by the method of Bancroft and Curtis (1957). At the beginning of the experiments the weight and the virus content of the inoculum were also determined in a control sample. The difference between these values was used as a measure for the growth and the virus synthesis. In FIGURE 1 the growth of the roots is represented in percentages of the control without thiouracil or cytovirin, respectively, and the virus content of the roots is expressed as percentages of the control. As can be seen, the growth of the roots was more affected by the two substances than was the virus synthesis. For instance, there was no reduction of virus synthesis with concentrations of thiouracil that reduced root growth more than 50 per cent. On the contrary, there seemed to be a small increase in virus production in this range, but the increase was not significant. Statistically examined, the difference between the two points 10^{-6} gm./ml. and 2×10^{-6} gm./ml. thiouracil gives a P of only 0.05. The increase in virus content was emphasized, however, because Hildebrandt (1958) had published a table on the effect of purines and pyrimidines on the growth and the virus concentration of tobacco tissue cultures in which there was a slight virus increase in thiouracil-treated tissues, with a simultaneous decrease in tissue growth. I think it may be of interest to examine this further.

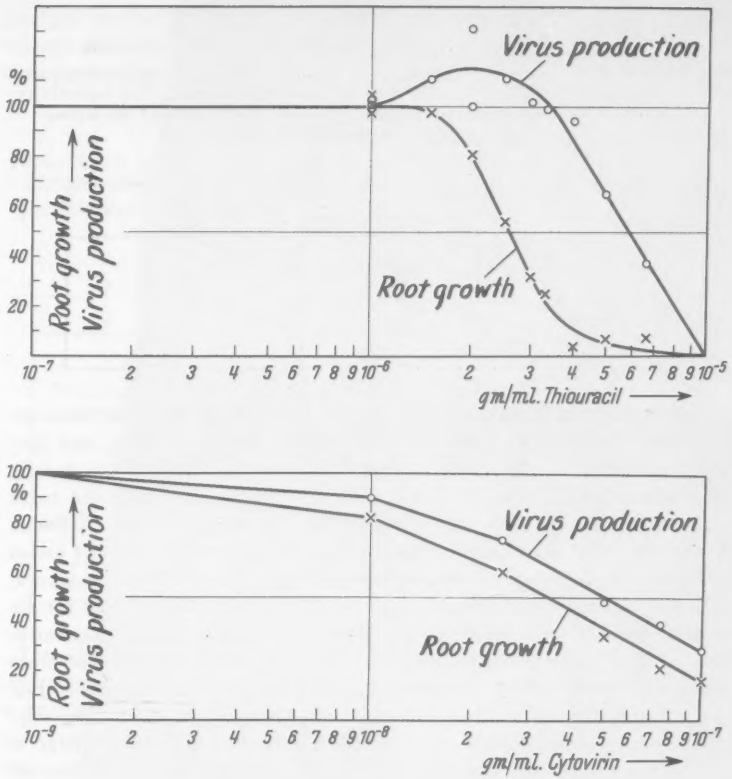


FIGURE 1. The influence of thiouracil and cytovirin on the growth and the virus production of excised tomato roots infected with tobacco mosaic virus.

Cytovirin also causes a visibly greater inhibition of growth than of virus synthesis. This growth inhibition was confirmed by Wittmann (1958) on tobacco plants. Virus synthesized in roots grown with cytovirin had as much infectivity as virus from controls (TABLE 3). This is remarkable because virus from plants treated with 8-azaguanine or thiouracil was less infectious than the control material (Bawden, 1954; Matthews and Smith 1955), which suggests that cytovirin acts in a manner different than thiouracil.

Infection of Submerged Tissue Cultures

It is well known that in the past plant cells could be infected with virus only by wounding the cells and subsequently introducing virus through the wounds. Nevertheless, it seemed worthwhile to attempt to infect tissue cultures in a way other than by wounding, because we

TABLE 3

INFECTIVITY OF VIRUS FROM ROOTS TREATED WITH CYTOVIRIN

The Virus Content of Root Homogenates Was Determined Spectrophotometrically and the Homogenates Diluted in Respect to the Virus Content. The Infectivity is Given in Average Numbers of Local Lesions/40 Leaves of *Nicotiana tabacum* var. *"Xanthi necrotium"*

	Virus content of homogenates	10^{-5}	10^{-6}	10^{-7}
	γ/ml.			
Control roots	105	368	56	8
Cytovirin 5×10^{-8} gm./ml.	52	171	32	6

observed that cells in tissue cultures have very thin walls and because it may be possible to obtain free plasmodesmata by dividing and dissociating cells in submerged cultures. In connection with this the finding of Koblitz (1958), that in tissue cultures of *Daucus carota* the cells built only a primary cell wall is remarkable. Therefore, a line of tobacco tissue was cultivated from *Nicotiana tabacum* var. "Samsun" and grown in liquid media (Bergmann and Melchers, 1958). Flasks with a magnetic stirrer (Melchers and Bergmann, 1958) or shaker flasks were used for the cultivation. A sterile suspension of tobacco mosaic virus in a concentration of 10^{-7} gm. virus/ml. was added to the media. The tissues were allowed to grow for 4 to 6 weeks in the presence of the virus and then the virus content of the tissue pieces was tested in the following way. The tissues were washed and homogenized with phosphate buffer at *p*H 7.0 and the homogenate diluted so that 1 gm. of tissue was dispersed in 1 ml. of the buffer. This concentration was called 10^{-1} and from it further dilutions were made after the tissue particles were removed by centrifugation. The number of lesions produced by the diluted suspension on tobacco plants was used as a measure of virus content. The tests were made with plants of *Nicotiana tabacum* var. "Xanthi necroticum" (Takahashi, 1956) because they are more sensitive than *Nicotiana glutinosa*.

The result of one of the tests is shown in TABLE 4. In this particular experiment we tested 4 samples of tissues from 1 flask, each sample containing 3 or 4 single tissue clumps. We found 3 samples with virus and 1 without virus. As may be seen from TABLE 4, a 10^{-3} dilution of sample B, that is, 1 mg. tissue in 1 ml. buffer, gave a number of lesions of the same order as the control suspension that was adjusted to 10^{-7} gm. virus/ml. The virus multiplication in sample B was of the order of 10^3, in the samples C and D of the order of 10^2. The virus concentration of the tissues was of the order of 10^{-4} gm. virus/gm. tissue and 10^{-5}

gm./gm. for the samples C and D. In relation to the fresh weight of the tissues the virus content was 0.01 per cent for sample B and 0.001 per cent for samples C and D.

TABLE 4

INFECTIVITY OF TMV OF HOMOGENATES FROM TOBACCO TISSUE CULTURES INCUBATED AND STIRRED FOR 6 WEEKS IN LIQUID MEDIA WITH 10^{-7} GM. TMV/ML.

The Infectivity is Given in Average Numbers of Lesions/Plant Produced on *Nicotiana tabacum* var. *"Xanthi necrotium"*

Sample		*A*	*B*	*C*	*D*
Weight, gm.		0.956	0.625	0.658	1.025
Dilution of the tissue homogenates, gm./ml.	10^{-3}	0	154	15.6	10.2
	10^{-4}	0	7.0	0	0
	10^{-5}	0.	2.6	0	0
Control, 10^{-7} gm./ml.		135.6			
Medium at the end		10.4			
Virus content, per cent of weight		0	0.01	0.001	0.001

The assumption that the virus content of the tissues was the result of adsorption of virus on tissues and not of infection of these tissues can be excluded for two reasons: (1) the virus content of sample B alone was higher than the virus amount put in the flask at the start of the experiment; and (2) if the virus content of the tissues resulted from adsorption of the virus on the tissues, the lack of virus in sample A could not have occurred.

The lack of virus in sample A indicated further that the inoculation of tissues occurred only by the wounding of cells and not in any other way. To prove this in other experiments, we have cultivated the tissues in shaker flasks, hoping they would be less wounded under these conditions than in the stirred cultures. To some of the flasks we added fine quartz powder to obtain more wounds and infections than in the earlier experiments. To prevent an infection through wounds formed in tissues during their transfer into flasks, the virus suspension was added 24 hours later. After 42 days the virus content of the tissues was tested. The result was unexpected. As seen in TABLE 5, there was only a slightly higher number of infections in the tissues cultivated with quartz as compared to the tissues grown without quartz. Presumably, the reason for this is the following: most of the quartz particles were lying on the bottom of the culture vessels during the experiment, whereas the tissues were

TABLE 5

INFECTIVITY OF TMV OF HOMOGENATES FROM TOBACCO TISSUE CULTURES INCUBATED IN LIQUID MEDIA WITH 10^{-7} GM. TMV/ML. ON A SHAKER WITH AND WITHOUT QUARTZ POWDER

The Cultures were Grown for 7 Weeks. The Dilution of the Tissue Homogenates was 10-2. The Virus Infectivity is Given in Average Numbers of Local Lesions/Plant of *Nicotiana tabacum* var. *"Xanthi necrotium"*

	+ *Quartz 1*		+ *Quartz 2*		+ *Quartz 3*		+ *Quartz 4*	
	a	*b*	*a*	*b*	*a*	*b*	*a*	*b*
Growth of the tissues	2.3	2.5	5.2	5.3	1.42	1.43	3.4	2.7
Virus content of the tissues	175.3	0	2.0	0	179.0	0	140.3	215.3
Virus content in the medium at the end	19.0		0		7		35.0	
Control 10^{-7} gm./ml.	402.0							
Virus content of the tissues in per cent of fresh weight	0.001		0.00001		0.001		0.001	0.001

	− *Quartz 1*		− *Quartz 2*		− *Quartz 3*		− *Quartz 4*	
	a	*b*	*a*	*b*	*a*	*b*	*a*	*b*
Growth of the tissues	3.1	3.2	1.4	1.4	0.7	0.8	3.4	3.1
Virus content of the tissues	0	0	675.0	27	4.3	450	0	0
Virus content in the medium at the end	5		32.0		27.0		59.0	
Control 10^{-7} gm./ml.	402.0							
Virus content of the tissues in per cent of fresh weight	0	0	0.003	0.0001	0.00001	0.001	0	0

floating in the nutrient, their specific gravity being about the same as that of the nutrient. Thus there was little contact between quartz and tissues, which presumably accounted for the comparatively small number of infected cells.

The virus concentration in the samples in this experiment ranged between 0.002 and 0.00001 per cent of the tissue fresh weight. Therefore the rate of infection is probably lower than in the experiments with stirred cultures in which more tissues were wounded. The great differences in the virus concentration are explained by the fact that not all tissues became infected; therefore the single samples were composed of different numbers of infected and noninfected tissue clumps. The actual amount of virus in a single infected tissue piece accordingly must be higher. We have demonstrated this by testing single tissue pieces and finding a virus concentration of 0.04 per cent of the tissue fresh weight. This amount is in good agreement with the virus concentrations of tissue cultures isolated from systemically infected tobacco plants (Kassanis, 1957).

In conclusion it may be said that we were able to infect isolated roots and plant tissues in culture with tobacco mosaic virus and to compare the growth of infected and noninfected tissues. The usefulness of this procedure was demonstrated in testing chemotherapeutic agents. The successful inoculation of submerged cultures with and without the use of quartz powder was also described, and the low efficiency was emphasized. Although the results presented here constitute only a beginning, I am optimistic that we shall be able in the near future to overcome or circumvent the obstacles presented by the plant cell wall so as to infect plant tissues or single plant cells with much greater efficiency than we can today.

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II. TISSUE CULTURE FOR ARTHROPOD VIRUSES*

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Although the first attempt to culture insect tissues under *in vitro* conditions was made by Goldschmidt (1916), little progress was made until quite recently. The main obstacles to achieving long-term growth and survival of the cultured tissues were twofold. First, very little information was available on the chemical composition of insect blood. Without knowing what chemicals and their quantities were present in the blood it was extremely difficult, if not impossible, to formulate a medium that would support the growth of the tissues for any length of time. Second, many of the earlier workers in this field were not primarily interested in growing the tissues for considerable lengths of time. Their main interest was the study of gametogenesis and the mechanism of mitosis and meiosis. These investigations required only very simple media that would maintain survival of the tissues for short periods – seven days at the longest and, in many experiments, only a few hours. The media usually consisted of a simple salt solution (in many instances these were very similar to vertebrate saline solutions) with perhaps a sugar added as an energy source.

In later experiments (chiefly during the period 1928 to 1935) it was realized that to grow insect tissues for long periods the medium needed would be complex and would contain all the factors necessary for normal and sustained growth of the tissues. Consequently many workers used various tissue extracts both from insect and vertebrate sources in the hope that any growth factors present would become available to the tissues. At this time also there were advances in knowledge of the composition of insect blood, and this information was used in the making of media. Unfortunately the analyses were still mainly qualitative and, although it was known with some certainty what substances were present in insect blood, there was no adequate quantitative analysis.

Between the years 1916 and 1954 (with the exception of the outstanding experiments carried out by Trager in 1935) every attempt to culture insect

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tissues had resulted in very little growth and survival for short periods only.

In 1956 Wyatt published a paper on the cultivation of ovarian tissues of the silkworm *(Bombyx mori)*, which was very important because it was the first time that insect tissues were grown in a medium formulated from a careful quantitative analysis of insect blood. The medium consisted of salts, sugars, 22 amino acids, and 10 per cent of heat-treated insect blood. In this medium Wyatt maintained very active growth of cells from the lining sheath of the ovariole for as long as 2 weeks and the cells survived for about 4 weeks.

Although this medium gave the best results, it would not sustain growth for long periods. By the addition to it of cholesterol, 10 members of the vitamin B complex, and reduction of the concentration of blood from 10 per cent to 5 per cent (Grace, 1958), it was possible to grow ovarian tissue from 3 species of Lepidoptera for long periods and to keep them surviving almost indefinitely. The ovarian tissue of the Promethea moth *(Callosamia promethea)* grew in culture for 160 days and survived for 55 weeks, and the ovarian tissue of the Cynthia moth *(Samia walkeri)* has shown growth of cells for 306 days and survival for at least 52 weeks (Grace, unpublished results). Some growth has also been obtained in cultures of pupal wing tissue, fat body, and testis tissue from lepidopterous pupae.

It might be asked to what problems can the technique of insect tissue culture be applied. In answer to this question it can be said that in the past five years almost every attempt to culture insect tissues *in vitro* has been directed toward answering problems concerned with the transmission by insects of viruses that cause disease in plants and animals. More recently it has been found useful in studying more closely how viruses that cause diseases in insects multiply in the host's body and in problems of latency in insect viruses.

The Multiplication of Plant Viruses in Insect Tissues Grown in Vitro

For some years it has been known that viruses of aster yellows, rice stunt, club leaf, and wound tumor are able to multiply in both a plant and in the insects that transmit the viruses to the plants. As these viruses are able to multiply in both plant and animal it has been suggested by Maramorosch (1952) that they were originally insect viruses and only secondarily have come to infect plants. For this reason they are considered here as arthropod viruses.

Although the experiments of Black (1941) and, later, of Maramorosch (1952) showed fairly conclusively that the aster yellows virus could multiply in its vector—the aster leafhopper (*Macrosteles fascifrons*, Stal.)—there was still the possibility that phloem juices or, perhaps, other plant substances ingested by the insect during feeding could play a part in the multiplication of the virus in the insect.

In 1956 Maramorosch carried out a series of experiments to prove conclusively that the aster yellows virus could multiply in the aster leafhopper. Aster leafhoppers were fed on plants infected with aster virus for 2 days. They were then cut into small pieces and set up in hanging-drop preparations. After 10 days in culture the surviving tissues were finely ground and, after centrifugation, the cell-free supernatant was injected into virus-free leafhoppers (1/5000 ml./insect). The injected leafhoppers were then allowed to feed on virus-free aster plants. The results were interpreted as showing multiplication of the virus, but more extensive experiments must be carried out to justify this conclusion.

It is of some importance to both plant pathologists and insect virologists to be able to culture the tissues of insect vectors of plant diseases. Several attempts to obtain growth of cells and tissues of the aster leafhopper and the leafhopper *(Dalbulus maidis)*, which is the vector of corn-stunt virus, met with little success. Although the gut tissue would survive *in vitro* for several days, no growth of cells or tissues was ever observed. It is possible that the media used in these experiments were not adequately defined for growth to occur (Grace, unpublished observations). Although we know that multiplication takes place in the insect, there is little information available on the site of multiplication. Recent work by Littau and Maramorosch (1956) has suggested that the site of multiplication could be the fat body, but definite evidence is still needed.

The Growth of Animal Viruses in Insect Tissues Grown in Vitro

As in the case of viruses that cause diseases in plants, there are a number of viruses transmitted by insects that cause pathological conditions in animals. Some of these, such as the virus of equine encephalomyelitis, multiply in the tissues of the insect vector and will be regarded as arthropod viruses.

The only experiments carried out to study the multiplication of an animal virus in its insect vector were those of Trager (1938), who showed that the virus of the western strain of equine encephalomyelitis is able to multiply in the presence of *Aedes aegypti* tissues surviving *in vitro*. The virus, obtained from mice sick with the disease, was added in solution to cultures of mosquito larval thoracic tissues. At the end of 28 days, during which the virus had been subcultured to pupal head tissue, the virus titrated 100,000 times higher than in the original suspension. The encephalomyelitis virus, after 28 days in insect tissue culture, was passed through mice 13 times and was then tested on guinea pigs, in which it produced the typical disease. Trager also observed in these cultures that certain mosquito tissues may be more favorable for the growth of the virus than others.

Insect Polyhedral Viruses Grown in Insect Tissue Culture

Since Bergold (1947) first showed that the infective agent in the so-called polyhedral diseases of insects was a virus embedded in a polyhedral capsule, there has been increasing interest in the study of viruses that infect insects. The polyhedral viruses are characterized by large polyhedral bodies formed either in the nuclei of cells of the fat body, epidermis, or trachea, or in the cytoplasm of the gut cells of the Lepidoptera. The bodies are quite large (1 to 3 μ) and irregular in shape and, consequently, they are exceptionally useful in studying the formation and multiplication of viruses in insects. The first experiments to study the multiplication of these viruses in insect tissue culture were those of Trager (1935). Trager was able to observe the multiplication of the polyhedral bodies of the virus grasserie in cultures containing cells that grew from the lining of the ovariole of the silkworm.

The only other experiments in this field have been carried out in order to study latency in insect viruses (Grace, 1958). In a series of experiments set up primarily to test the effect of the addition of various concentrations of Eagle's basal medium on the growth of cells from the ovary of the tussock moth *(Hemerocampa leucostigma),* polyhedral bodies appeared in some of the cultures after a change was made in the media used. In 1915 Chapman and Glaser reported a polyhedral disease in larvae of the tussock moth.

In one series the ovaries were cultured in media containing 2, 3, 10, or 20 per cent of Eagle's basal medium in Wyatt's modified medium (Grace, 1958) plus 3 per cent plasma from diapausing pupae of the Promethea moth *(C. promethea).* These cultures will be designated 2Ep, 3Ep, 10Ep, and 20Ep, respectively. A second series of cultures was set up in media which were the same except for the fact that no insect blood was added (2E, 3E, 10E, and 20E respectively). Examination of the cultures 5 days after they were initiated showed that those that contained blood had achieved normal growth, whereas the growth was poor in the cultures to which no blood was added. In order to save the latter cultures, the media 2E and 3E were replaced with the media 10Ep and 20Ep, respectively.

In all the cultures in which the media had been changed it was noticed about four days later that many of the nuclei were filled with large granules. On microscopic examination of the infected cells it was possible to observe that the bodies were restricted to the nuclei, the cytoplasm remaining free and clear. Three days later every cell in these cultures was infected.

Some of these bodies were transferred to other cultures that were growing normally and had not received a change in the medium. Again, 4 days later, bodies were present in the nuclei and, by the seventh day, every cell was infected. The next summer polyhedral bodies from

the infected tissue cultures were injected into half-grown tussock moth larvae. Typical symptoms of a polyhedral disease became manifest in 60 per cent of the larvae in about 5 days.

To account for the phenomenon observed, it was postulated that the larvae used in these experiments carried a latent infection of a polyhedrosis that became manifest after the cultures were subjected to a "physiological shock" brought about by an abrupt change from one medium to another.

At the present time very little use has been made of insect tissue culture as a technique in studying problems concerned with the transmission of animal and plant viruses by insects. I am of the opinion that, in order to solve many of the problems concerned with the multiplication of these viruses in insects, it will be necessary to grow the tissues outside the body of the insect. In this respect, insect tissue culture is an ideal technique for the study of such problems.

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III. STUDIES ON P^{32}-LABELED POLIOVIRUS*

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There is now abundant evidence to indicate that the ribonucleic acid (RNA) and protein of certain plant and animal viruses have independent biological functions to perform during the process of infection. Indeed, it is easy to accept the plausible working hypothesis that RNA is the germinal substance of these viruses. One of the possible fruitful lines of approach suggested by this hypothesis is a biochemical study of the transfer of RNA from parental infecting virus to progeny by methods similar in principle to those used to study DNA transfer in bacteriophage work. For such work, it is essential to obtain a purified RNA-containing virus labeled with a radioactive tracer in the RNA moiety. We have been trying to establish the poliovirus-monkey kidney cell system for this purpose and this paper is a discussion of some of the factors that must be considered before the system can be judged suitable for the biochemical experiments.

We have described elsewhere in detail a method for purifying P^{32}-labeled poliovirus.[1] Briefly, monkey kidney cells were labeled by cultivating them in a medium containing inorganic P^{32}, and were then infected with MEF-1 virus in a medium that contained P^{32} but no serum. When the cells had lysed from virus action, the lysate was dialyzed against dilute phosphate buffer and then applied to a column of Dowex-1 chloride anion exchange resin. The virus was adsorbed to the resin and could be eluted with 0.05 M sodium chloride; the virus elution peak coincided with an isolated P^{32} peak. Essentially complete recovery of the virus was obtained with up to one hundredfold decrease in specific activity (counts per minute per plaque-forming unit). A small amount of P^{32}, which was trichloroacetic acid-soluble, was then removed from the virus by sedimenting the virus in an ultracentrifuge. Analyses of the virus purified

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in this way showed that all the P^{32} was contained in particles that sedimented at the same rate as poliovirus and in the chemical fraction that corresponded to RNA.

It is necessary to determine whether all the P^{32} of these preparations is associated with infectious particles. The first question we ask is what are the relative rates of adsorption of P^{32} and infectivity to susceptible cells. The following experiment supplied this information. To each of a number of primary monkey kidney cell cultures was added a quantity of phosphate-buffered saline (PBS) containing P^{32}-labeled, purified virus. In parallel, a similar quantity of virus that had been inactivated to 1 per cent survival, by heating to 50° C. for 90 min., was added to another set of cultures. The plates were incubated at 37° C. At intervals, 2 plates from each set were washed with PBS and the washings were assayed for virus activity and P^{32}. The results are plotted in FIGURE 1. For "live" virus the rates of adsorption of infectivity and P^{32} were exponential and parallel, at least until 80 per cent had been adsorbed. P^{32} of the thermally inactivated preparation was not adsorbed by the cells. Other experiments have shown that, if labeled virus is placed on cells resistant to infection by MEF-1, there is no adsorption of P^{32}.

Thus, the P^{32} of these purified preparations is all contained in the RNA of particles that sediment at approximately the same rate as poliovirus, that adsorb to poliovirus-susceptible cells but not to resistant cells, and that will no longer adsorb to susceptible cells after thermal inactivation. The P^{32} seems, therefore, to be associated with virus-specific material. Furthermore, our preparations apparently contain very little thermally inactivated virus.

The isotope could be contained in infectious particles, in noninfectious particles still capable of being adsorbed by the host, such as incompletely formed virus, or in fully formed particles inactivated in some way other than thermally and still able to be adsorbed. Current estimates[2] of total particle to infectious particle ratios for purified MEF-1 virus (about 60) with the electron microscope would indicate a large excess of noninfectious particles. However, these estimates depend directly on the efficiency of virus titration and, before accepting them at face value, we should inquire closely into the factors that could affect the biological assay.

The efficiency of virus titration by plaque assay may be decreased by failure of adsorbed virus to multiply in the cells or by incomplete adsorption of virus to the cells. Considering, first, the possibility that adsorbed virus may not go on to multiply, we ask whether all the cells in a monkey kidney population can support growth of virus. The following experiment shows that they can.

MEF-1 virus was added, in high multiplicity, to cultures of monkey kidney cells (17 to 100 infectious particles per cell). After an adsorption

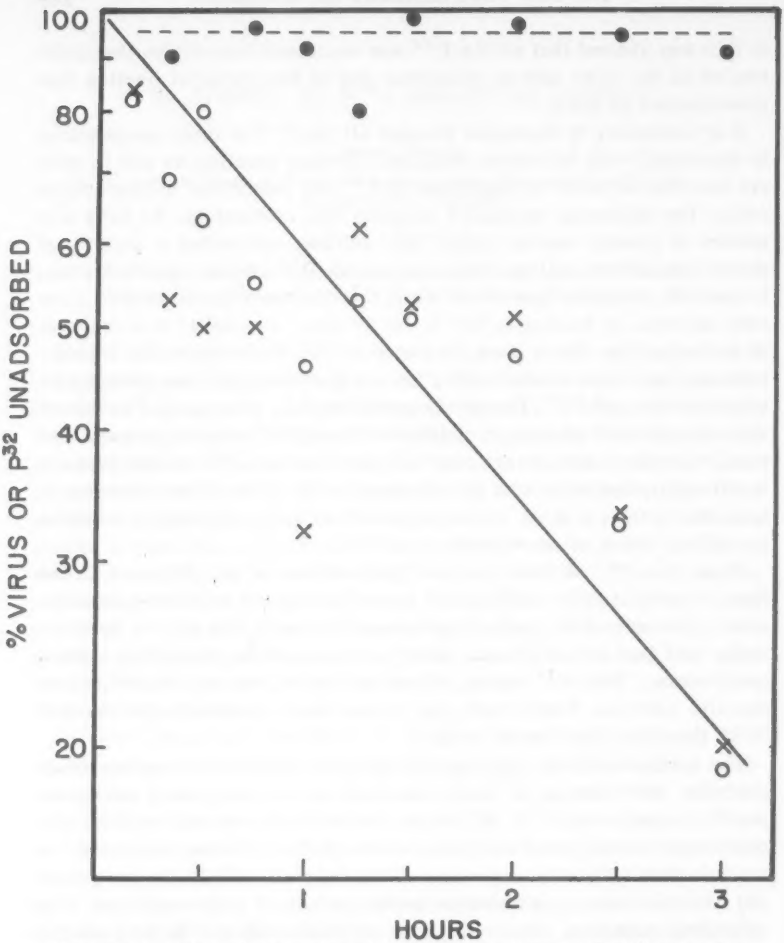

FIGURE 1. Rates of adsorption of infectious particles and P^{32} by monkey kidney cell monolayers from a purified labeled virus suspension. Crosses, P^{32} of live virus; open circles, virus; closed circles, P^{32} of heat-inactivated virus.

period long enough to permit virus to become adsorbed to every cell, the cells were washed, suspended, counted, and plated on fresh cell layers to determine the number that gave rise to plaques. Each cell produced a plaque. In addition to showing that all the cells were virus producers, the experiment demonstrated that the efficiency of plating infected cells for plaque formation was unity. Because of the high multiplicities used, the experiment still left open the possibility that a large fraction of the cells may have to adsorb more than one virus to initiate infection. How-

ever, similar experiments carried out with multiplicities less than 1 showed that the number of infected cells was approximately that expected from the number of infectious particles adsorbed. Apparently the monkey kidney cell populations are homogeneous with respect to their ability to give rise to infected cells on adsorption of one virus, and we can rule out the possibility that cell heterogeneity reduces the efficiency of the plaque assay procedure.

Considering now the role of virus adsorption in the plaque technique, there are two points that should be mentioned. First, diffusion of MEF-1 virus through 1 per cent agar overlay is very inefficient; unless all the virus is adsorbed to the cell monolayer before overlay is poured, the plaque assay inadequately reflects the number of infectious units in a suspension. Second, the rate of adsorption of MEF-1 to monkey kidney cell layers is slow and markedly dependent on the volume of liquid from which virus is adsorbed; the rate of adsorption-fluid volume relationship for MEF-1 is similar to that already found for foot-and-mouth disease virus.[3] As FIGURE 1 shows, conditions can be found that allow 80 per cent of the virus to be adsorbed in 3 hours. These conditions, however, are not practicable for use in assay, since the very small fluid volume does not permit a uniform distribution of plaques. To circumvent these difficulties the following simple experiment was designed for estimating the total number of infectious units in a virus suspension.

Three sets of monkey-kidney monolayers were prepared in 10-cm. Petri dishes. To each plate of the first set were added 50 to 100 infectious particles in 0.5 ml. of PBS; the exact number of particles was unknown at this stage and we shall designate it as N. After a 90-min. adsorption period, the supernatant liquid from each plate was transferred to a plate of the second set. The cell layers of the first set were each washed with 0.5 ml. of PBS and the washings were transferred to plates of the third set. The plates of the first set were then overlaid with agar. After 90 min. for adsorption, the supernatant liquids from the second and third sets were discarded, the cell layers washed, and overlays poured. After 3 days the plaques on all 3 sets of plates were counted. If x, y and z are the average numbers of plaques on the first, second, and third sets, respectively, then

$$\frac{x}{N} = \frac{y + z}{N - x}$$

N, the original number of plaque-forming units added to each of the first set of plates, can be evaluated. TABLE 1 shows the results of several such experiments. Under ideal conditions N should be the absolute number of infectious units in the original virus suspension. Thus, if one titrates, in the routine manner, an MEF-1 virus preparation for which N is known, the plating efficiency is the ratio of the observed number of plaques to N. As TABLE 1 shows, the plating efficiency in our routine assay technique is 50 to 60 per cent.

TABLE 1

ESTIMATION OF THE NUMBER OF INFECTIOUS PARTICLES IN SUSPENSIONS OF POLIOVIRUS MEF-1

Virus preparation	*No. of plaques per plate in series*			*Calculated no. of infectious virus (N) added to series x**	*Calculated titer of virus preparation* p.f.u./ml.†	*Titer of virus preparation by standard procedure* p.f.u./ml.	*Plating efficiency of standard procedure (percentages)*
	x	*y*	*z*				
I	23.5	12.6	3.8	78	1.6×10^9	8.3×10^8	52
	39.5	11.5	3.0	63	1.3×10^9	7.6×10^8	58
II	24.8	15.8	2.8	98	9.8×10^8	5.6×10^8	57
	28.0	10.0	2.3	50	5.0×10^8	3.2×10^8	64
III‡	20.8	6.8	1.8	35	9.0×10^8	5.9×10^8	84

*Calculated from expression $\frac{x}{N} = \frac{y + z}{N - x}$ as explained in text.

†P.f.u., plaque-forming unit.

‡Purified virus preparation.

There are certain assumptions involved in the estimation of *N*, namely: (1) the rate of adsorption of MEF-1 virus to the cell monolayers is the same regardless of virus concentration; (2) the virus population is homogeneous with respect to adsorption rate; and (3) the cell population is homogeneous with respect to its ability to be infected. Without attempting further to discuss these assumptions at present, it may be pointed out that, under any set of assay conditions, an estimate of *N* provides the best basis for measuring the ability of a cell layer to produce plaques. Theoretically, since *N* is independent of differences in adsorption rates from one cell line to another, its estimated values for a virus preparation assayed on different cell strains are the best indicators of the comparative plating efficiencies. The commonly used technique of plating a virus preparation on layers of different cells, with a standard adsorption period, is not necessarily a sufficient comparison; the differences in virus titers may reflect only differences in adsorption rates.

We believe that our estimates of *N* for purified MEF-1 are close to the correct values. These estimates are still far short of the number of particles observed in the electron microscope, and we now ask if the preparations contain particles that kill the cells, but do not reproduce. This possibility may be tested by comparing the fraction of cells infected with the fraction killed when a population is exposed to virus. We have carried out some experiments along these lines, one of which is summarized in TABLE 2. In this experiment monkey kidney cell layers were exposed to purified, labeled MEF-1 virus for different times. The layers were washed and suspended and the cells plated: (1) on fresh monolayers to determine the fraction of cells infected; and (2) to determine the fraction that would give rise to colonies.[4] This experiment, and the others we have performed to date, is open to the criticism that the colony-forming efficiency of the uninfected cell population was only about 10

TABLE 2

CORRELATION BETWEEN NUMBER OF CELLS INFECTED AND NUMBER OF CELLS KILLED BY POLIOVIRUS MEF-1

Adsorption period (minutes)	*Multiplicity of infection**	*Cells adsorbing virus (percentages*)*	*Cells infected (percentages)*	*Cells killed (percentages†)*
30	0.24	22	25	26
60	0.57	44	26	46
120	0.61	45	—‡	71

*Determined from the ratio $\frac{\text{number of infectious particles adsorbed}}{\text{number of cells per plate}}$

†Fraction of uninfected cells that gave colonies was 10 per cent.

‡Lost.

per cent. Nevertheless, the results of TABLE 2 suggest that there is no major discrepancy between the number of cells killed and the number infected.

Thus, we are faced with the unpleasant prospect that the P^{32} of purified MEF-1 preparations may be distributed across a particulate population containing only a few per cent of infectious units. The great majority of particles must contain RNA (or a value of 20 to 30 per cent by weight of RNA in purified virus[5] could not have been obtained), must adsorb specifically to cells at the same rate as the infectious units, and be noninfectious and innocuous to the cell, a combination of circumstances we find difficult to believe. At any rate, it is obvious that this situation must be resolved before the labeled virus can be utilized for transfer experiments.

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DIVISION OF PSYCHOLOGY

MEASURING THE PATIENT'S ANXIETY DURING INTERVIEWS FROM "EXPRESSIVE" ASPECTS OF HIS SPEECH*

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> "Is it not possible, under certain conditions and at certain times, for very important things to betray themselves in very slight indications?"
>
> - Freud[1]

One of the verbal-stylistic dimensions is the subject matter of this paper. This is the dimension of "roughness" or "influency" or "disturbance" of the word-word progression in the unfolding of verbal expression. Research in progress points to many interesting aspects of this expressive facet of speech,[2,3] but this presentation deals only with the relationship between the "normal disturbances" of speech and the immediate, concurrent anxiety state of the speaker.

Our initial interest in this relationship came from two sources: the systematic study of psychotherapy and the investigation of psychosomatic relations. Since these origins affected the lines of approach we have followed, I shall first comment briefly on them.

The patient's anxiety is at the heart of the psychotherapeutic process. Fluctuations in it determine the course of defensive and resistive processes, and they are intricately involved in the activation, uncovering, and expression of significant emotional material – all of which lead to therapeutic change. Significant research on the therapeutic process must have, as one of its variables, the patient's anxiety. There arises immediately the problem of finding a meaningful and useful measure of anxiety.

Another factor was also operating at the outset of the present research, and it influenced the steps taken. This was an interest in investigating psychosomatic correlates of anxiety in humans in spontaneously occurring "real life," interpersonal situations of such a nature that one possessed the maximum amount of information possible about the meaning of these situations to the subject. The intensive psychotherapeutic interview seemed to be just such a situation. Again, there arose the problem of finding a useful measure of anxiety; for psychosomatic purposes, the measure was necessarily nonphysiological.

For the goals in mind, there were three classes of potential measures: manifest verbal content measures, clinical judgments, and measures based on the behavioral or expressive dimensions of speech.

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Uninterpretive manifest content analysis, where no cognizance is taken of the defensive and instrumental significance of the content, was rejected a priori on theoretical grounds as being an inherently invalid procedure for the present purposes. Subsequent studies[4,5] have supported this initial position in the case of one manifest content measure.

Raw clinical judgment did not appear to be a feasible method meeting all the requirements noted earlier. Also, it seemed apparent at the outset that in any attempt to develop reliable and valid clinical judgment this type of evaluation would soon resolve itself into an explicit assessment of interpreted content or of the expressive aspects of speech. Therefore, it seemed reasonable to focus intentionally on some of those clues that we use fairly uniformly in therapeutic work: these included defensive maneuvering, pauses and silence, and disturbances in the process of speaking itself. Some work has been done on all three of these criteria, but most of it has been concerned with the disturbances in speech.

Speech Disturbance Categories and Measure

The following is a brief verbatim excerpt from a therapeutic interview between a patient (P) and a therapist (T). Its "confused," "flustered," or "garbled" quality is notable. At other times this same patient spoke beautifully and fluently.

P: My uncle had his throat cut.

T: Mmm.

P: And my uncle...ah...he wasn't killed, but they tortured him. They took him and they slit his throat right...the skin...just cut the skin right around like this here.

T: Who did that? *(said in a sudden manner)*

P: Mmm...hulligan...holigan...hulligans, whatever you call them.

T: The who?

P: The...ah...you know the...ah...sss...he was in...the...he...was ...dri...traveling from one town to the oth...next and-

T: Mmmhnn.

P: – he was stopped by a couple...ah...if you know the situation in the South...

T: Were...were they...were they Russians or were they Bolsheviks?

P: Yes. Yeah...mujiks...peasants.

When a therapist hears such disrupted speech in an interview he immediately takes it to earmark areas of conflict and anxiety. Sometimes it seems obvious in view of the manifest content or the reality situation that the patient would be frightened as he speaks. However, at other times this is not at all clear and the therapist wonders to himself, or with the patient, "What is he (are you) frightened about?"

In the clinical situation, the therapist characteristically hears "islands" of such disturbed speech, occurring as more or less distinct

episodes in otherwise undisturbed utterance. The original intent was to identify in recordings such instances of flustered or confused speech by the patient. One could then proceed to do various things with them. They could be counted, for example, and this count could be combined with measures of silence and judgments of defensive behavior to yield an over-all anxiety score for individual interviews.

When I started to work in this vein the study of transcripts and recordings immediately revealed two things. The first was that clinically perceived episodes of flustered speech consist of definite identifiable categories of disturbance. The term "flustered" or "confused" speech is more indiscriminate than it need be. The second was that these identifiable disturbances occur at varying rates throughout the course of an interview. The listener may or may not perceive them. Speech may be literally peppered with various disturbances, but it is only when these occur at relatively rapid rates – when they are "bunched" – that the listener perceives them, and then he senses an episode of flustered speech.

It appeared that there was actually a dimension of speech here, over which there was considerable range, that could be measured by identifying and counting the individual categories of disturbance and that, possibly, one could obtain in this way an objective, sensitive, continuous measure of anxiety. At the same time there were many doubts in my mind that this type of analysis would yield anything valid. I wondered, for example, if all the less frequent nonfluencies occurring when one did not clinically experience the speech as flustered were no more than "random noise" in speech. Could it be that they were always present and were brought to one's attention only through the use of recordings and transcripts? Would such a proposed measure of disturbance mean the same things as the clinically sensed speech changes? The doubt contributed to the motivation to carry on the work.

TABLE 1 contains definitions and examples of the category set now used in identifying speech disturbances. The categories were developed empirically by the close study of tape recordings and transcripts for psychotherapy interviews. At the present time the set has been applied to the speech of additional patients in psychotherapy and to a variety of other speakers and situations – interviewers in initial and therapy interviews, college undergraduates in a role-playing experiment and in investigative interviews, and university faculty members in seminar discussions. Generally speaking, the category set has proved to be adequate for identifying practically all those events sensed as "normal speech disturbances" in the preceding variety of speakers and situations. (Momentary hesitations and longer pauses are also sensed as disruptions in speech. They are not included in the category set, for they are measured separately by another procedure.[6])

TABLE 1

DEFINITIONS AND ILLUSTRATIONS OF THE SPEECH DISTURBANCE CATEGORIES

Category	*Examples*
(1) *"Ah."* Wherever the "ah" sound occurs it is scored. Less frequent variants are "eh," "uh," "uhm."	Well. . .ah. . .when I first came home.
(2) *Sentence change.* A correction in the form or content of the expression while the word-word progression occurs. To be scored, these changes must be sensed by the listener as interruptions in the flow of the sentence.	Well she's. . .already she's lonesome. That was. . .it will be two years ago in the fall.
(3) *Repetition.* The serial, superfluous repetition of one or more words—usually of one or two words.	'Cause they. . .they get along pretty well together. He was. . .he was sharing the office.
(4) *Stutter.*	It sort of well l..l..leaves a memory.
(5) *Omission.* Parts of words, or rarely entire words, may be omitted. Contractions not counted. Most omissions are of final one or two parts of words and are associated with sentence change and repetition.	She mour. . .was in mourning for about two years before. Then their anni. . .wedding anniversary comes around.
(6) *Sentence incompletion.* An expression is interrupted, clearly left incomplete, and the communication proceeds without correction.	Well I'm sorry I couldn't get here last week so I could. . .ah. . .I was getting a child ready for camp and finishing up swimming lessons.
(7) *Tongue slips.* Includes neologisms, the transposition of entire words from their "correct" serial position in sentence, and the substitution of an "unintended" for an intended word.	We spleat the bitches (for "split the beaches"). He was born in their hou(se). . .hospital and came to their house. The reason that I don't. . .didn't seem to feel the love for him (son) that I felt for J. .(daughter).
(8) *Intruding incoherent sound.* A sound which is absolutely incoherent to the listener. It intrudes without itself altering the form of the expression and cannot be clearly conceived of as a stutter, omission, or neologism (though some may be such in reality).	If I see a girl now I'd like to take out I just. . .dh. . .ask her.

A useful measure of the level of speech disturbance can be obtained by identifying the various disturbances in a verbatim transcript and then computing the following ratio for any given language sample:

$$\text{Speech disturbance ratio} = \frac{N \text{ speech disturbances}}{N \text{ ``words'' in sample}}$$

It has been our experience that certain of the categories can be scored only by listening to the tapes while simultaneously reading the transcripts. Therefore, this procedure is followed uniformly. Idiosyncratic or poor grammar and inaudibility are not grounds for scoring disturbances.

In the studies to be cited below we have found that the "ah" category should be omitted from the speech disturbance ratio if it is to be used for anxiety measurement.[3,7,8] All the remaining categories (non-ah disturbances), however, are used in this instance, and the following ratio is computed for whatever language sample is chosen for assessment:

$$\text{Non-ah ratio} = \frac{\Sigma \text{ non-ah disturbances}}{\text{N ``words'' in sample}}$$

The interscorer reliability of the non-ah ratio is quite high, being +0.91 in one study[6] and +0.96 in a second study.[8]

This, then, is a reliable measure of the speech disturbance level. What is the evidence that it is an indication of the speaker's anxiety? The following section deals with this question.

Anxiety and Speech Disturbance Level (Non-ah)

Four lines of study have shed light on the nature of this relationship. The first approach was to make *ad hoc* clinical evaluations of the proceedings within interviews and the changes in the speech disturbance level. The goal here was simply to see if it made sense – on the basis of our understanding of the patient and the therapeutic interview interchange – to view the fluctuations in the speech disturbance level as indications of corresponding variations in the patient's anxiety. The findings were almost entirely positive. They are illustrated by observations the reader can make for himself on the excerpt from a transcript presented below. Here one will find a 40-year-old male patient intermittently voicing negative feelings he harbors towards his nine-year-old son, as well as feelings of estrangement from him and jealousy and rivalry with his in-laws. At first he does this unintentionally by means of a tongue slip and later as a result of promptings by the therapist. Interspersed are brief, varied attempts to ward off such material. As one can see, the speech disturbances come and go with the rapid oscillation between expression and defense or avoidance.

Transcript

Abbreviations. (1) In transcript: P = patient, T = therapist; (2) in left margin: SC = sentence change, R = repetition, St = stutter, O = omission,

TS = tongue slip, Inc = sentence incompletion, and IS = intruding incoherent sound.

TS, SC — P: My impression of my relation to D. (son) have always been that the reason that I don't...didn't seem to feel the love for him that I felt for J. (daughter) was that during the first sixteen months of his life I was away. I didn't grow up with him. If there was any jealousy of D. it was in relation to his in-laws. Now that is very possible. Although it's something which I also suppressed. Ah...and the reason I say it's possible 'cause

2 St, R — it sort of well le...le...leaves a...ah...a sort of memory. Then I (?) I...

T: You're jealous of his in-laws?

R, TS, O, SC — P: Of his in-laws, yeah. Because he was brought up with them til...until I came home. He was born in their hou.*..hospital and came to their house, and my wife lived with her parents.

T: Ho...how do you mean you're jealous of his in-laws?

P: Well...ah...when I first came home, and for the first year or so, or more than a year...ah...D. was more prone to turn to his grandfather and grandmother than he was to me.

T: Mmmhnn.

SC — P: And although I understood it, there was a certain amount of...ah...well not bitterness, I wasn't bitter about it, but a certain amount of...a sort of resentment, a mild type of resentment.

T: You make this sound so...ah...

P: Well –

T: So diluted.

P: Well, it was diluted. I mean it wasn't something which I felt keenly enough to be angry at his grandparents, let's say, or with D. himself. I mean I realize that he had grown up with them.

T: Mmmhnn.

Inc, SC, St, R — P: And therefore, it was more natural for him to...until he became...completely o...overcame his...ah...strangeness to me, and it took quite a long time. Ah...then there was...there

IS, O(?) — was a certain amount of resentment. It wasn't directed against the parents or dec...was...den...ac. (IS, St) actually directed

O, SC, SC — against a circumstance which kept me away. And it was a resentment which re...in a certain...ah...to a certain extent reflected itself also in the *(clears throat)* feeling I had toward people who had remained behind and had made money.

T: Mmm. Your in-laws make money?

P: Yes. My father-in-law made a lot of money from the war.

Such *ad hoc* clinical evaluations were highly suggestive, but they were not adequate validation data themselves. Therefore a second method of study was instituted and has been completed with one patient. This was essentially an extension and refinement of the *ad hoc* clinical approaches that ruled out the possibility of uncontrolled contamination and bias in the clinical judgment. The rationale and nature of this validation procedure are as follows.

During therapeutic sessions and while studying recordings it often appears that interviews are divisible into natural segments or phases, each of which can be assigned to a single theme of content or interaction, and that the patient becomes anxious and conflictful in some, but becomes less anxious in others, especially in relatively sustained successful defensive maneuvers.

During live interviews, or in listening to recordings, judgments of such changes in anxiety are based in large part upon changes in expressive speech attributes. The assumption underlying this validation test was that, given adequate context for interpretation, it would be possible to judge such motivational phases in typescripts only for certain test interviews. If this were done validly, then the speech disturbance ratios for successful defensive phases should be lower than for anxious or conflictful phases. Detailed study of interviews other than the test interviews and psychodynamic formulations of the therapeutic situation at the time of the test interviews supplied the context for judging the motivational phases. Contamination was prevented by using edited verbatim transcripts that did not contain any speech disturbances or annotations and explict reference to pauses and silence. The clinical judge had no prior knowledge of the speech disturbances in the test interviews and the scorer of the disturbances had no knowledge as to the identity or meaning of the phases. This method was applied to six test interviews from the first thirty interviews of intensive psychotherapy with one patient.

The result of this controlled clinical study was that the mean speech disturbance ratio (non-ah) of 15 conflictful phases was significantly higher than the mean ratio of 15 defensive phases ($p < 0.001$, t test). A more detailed account of this study, including illustrations of the motivational phases, is contained in a previous publication.[9]

In a third study we correlated the speech disturbance ratios of 31 outpatient clinic applicants in their initial interviews with means of global ratings of manifest anxiety made by two independent observers of the "live" interviews. The reliability coefficient of the mean anxiety ratings was 0.82 for the entire sample. For the 20 women in the sample there was a significant, strong positive correlation of 0.59 between the non-ah ratio and the mean anxiety ratings. For the 11 men, however, there was a negative correlation of -0.47. While these results suggest at first glance a rather marked sex difference, the finding for the male patients is interpreted as basically ambiguous. There are two reasons for this conclusion.

First, there is some evidence that the judges were rating defensive (anxiety-reducing) behavior in the men, but manifest anxiety in the women.[7] The second and more important reason is that the reliability coefficient of the mean anxiety ratings was only 0.57 for the men. In contrast it was 0.86 for the women.

A fourth study[8] further clarified the situation with male speakers and also supplemented the basically correlational method of the 3 preceding studies with the direct experimental approach. There were 25 experimental subjects and 10 controls, all 35 being Yale undergraduates. Each subject was interviewed twice. For each subject, the first interview dealt superficially with a variety of significant aspects of his life – for example, his academic interests, vocational goals, dating activities, structure of his family, and relations with his parents. The tone of this first interview was that of a relaxed chat about the subject. For the 10 control subjects, there was more of the same in the second interview. In the second interview for the 25 experimental subjects, however, the interviewer attempted to induce moderate anxiety in the subject. To do so he probed cautiously into areas inferred to be conflictful for the particular subject, asked some questions about a personality test previously taken by the subjects, introduced occasional silences, and blocked attempts by the subject to change topics suddenly.

Speech disturbance ratios were determined from recordings and transcripts of the interviews. The effect of the anxiety interview was to increase significantly the non-ah ratio for the experimental subjects over what it had been in the neutral interview ($p < 0.001$, t test). Furthermore, this increase was significantly greater ($p = 0.03$, t test) than a slight rise from the first to the second interview for the controls.

In short, four converging lines of evidence support the conclusion that the speech disturbance ratio (non-ah) is a valid indication of the speaker's current anxiety level.

Sensitivity and Other Properties of Speech Disturbances

An earlier comment suggested that the speech disturbances are very frequent in the utterances of normal speech. Our data show that, for the variety of speakers and situations mentioned previously, there is on the average 1 of the non-ah disturbances for every 8 sec. actually spent talking (in addition, there is on the average 1 "Ah" for every 10 sec. spent talking). In spite of these high frequencies, most speakers and listeners are not aware of the vast majority of the disturbances they produce or "hear." Speech disturbances seem to be beyond the usual conscious control excercised in speaking. In addition, within wide limits these disturbances are not subject to social or linguistic control. All of these characteristics enhance the usefulness of the speech disturbance ratio as an anxiety indicator.

Our studies have also shown that the speech disturbance ratio makes rather sensitive discriminations. Thus, it produces statistically significant individual differences, significant differences between interviews for the same individual, and statistically significant variations from moment to moment within individual interviews.[2,9] In view of the validation data described above, these discriminations are to a large degree reflections of variability in the current anxiety in the speaker. The fact that very sensitive distinctions in anxiety may thus be presumed to be made by the speech disturbance ratio further increases the efficiency of the measure as an anxiety indicator.

Of course, other variables than anxiety may also affect the speech disturbance level. In fact, we have found suggestive data that the times of weaning and of speech onset in infancy are significantly related to the degree to which anxiety increases speech disturbances.[10] Exactly what other variables would lower the validity of the speech disturbance ratio as an anxiety measure, or possibly confound the situation, remains a question for further systematic research. Some relevant findings were obtained in the study with intake interviews. Here there was no relationship between the speech disturbance level and education, age, rate of talking, or degree of manifest hostility.[7]

It would appear that the speech disturbance measure could contribute to the systematic investigation of many important questions about the process of psychotherapy. There are, of course, many other research problems of human behavior that require an objective assessment of anxiety for their solution. The material presented suggests that the speech disturbance ratio might be of value in these instances also. It can be used in any case where there is speech.

References

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4. AULD, F. A. & G. F. MAHL. 1956. A comparison of the DRQ with ratings of emotion. J. Abnormal Soc. Psychol. 53: 386-388.
5. MAHL, G. F. 1957. Speech disturbances and emotional verbal content in initial interviews. Ann. Meeting, Eastern Psychol. Assoc.
6. KASL, S. V. & G. F. MAHL. 1956. A simple device for obtaining certain verbal activity measures during interviews. J. Abnormal Soc. Psychol. 53: 388-390.
7. MAHL, G. F. 1956. Disturbances in the patient's speech as a function of anxiety. Ann. Meeting, Eastern Psychol. Assoc.
8. KASL, S. V. & G. F. MAHL. 1958. Experimentally induced anxiety and speech disturbances. Ann. Meeting, Am. Psychol. Assoc.
9. MAHL, G. F. 1956. Disturbances and silences in the patient's speech in psychotherapy. J. Abnormal Soc. Psychol. 53: 1-15.
10. MAHL, G. F. & S. V. KASL. 1958. Weaning, infantile speech development, and "normal" speech disturbances in young adult life. Ann. Meeting, Eastern Psychol. Assoc.

CONFERENCES HELD

SECTION OF GEOLOGY AND MINERALOGY

MODERN ASPECTS OF THE GEOLOGY OF NEW YORK CITY AND ENVIRONS

Saturday, December 6, 1958

Conference Chairman: Kurt E. Lowe
Department of Geology, The City College, New York, N. Y.

Session Chairman: George C. Taylor, Jr.
U. S. Geological Survey, Ground Water Branch, Mineola, N. Y.

9:00 A.M. –

Greetings from the Academy – Kurt E. Lowe, Chairman, Section of Geology and Mineralogy, The New York Academy of Sciences, New York, N. Y.; The City College, New York, N. Y.

"Ground Water Problems in the New York City Area" – James J. Geraghty, Geraghty, Miller and Hickok, Consulting Ground-Water Geologists, New York, N. Y.

"Geology and Ground-Water Supplies of the South-Shore Beaches of Long Island, New York" – N. M. Perlmutter and H. C. Crandell, U. S. Geological Survey, Ground Water Branch, Mineola, N. Y.

"The Occurrence of Ground-Water Supplies in Pleistocene and Cretaceous Deposits of Northwestern Nassau County, Long Island, New York" – Wolfgang V. Swarzenski, U. S. Geological Survey, Ground Water Branch, Mineola, N. Y.

Session Chairman: George F. Adams
Department of Geology, The City College, New York, N. Y.

"Structure Section of the Hudson River at Nyack, New York from Seismic Observations" – J. Lamar Worzel and Charles L. Drake, Lamont Geological Observatory, Columbia University, Palisades, N. Y.

"The Palisades Ridge in Rockland County, New York" – H. D. Thompson, Department of Geology and Geography, Hunter College, New York, N. Y.

2:00 P.M. –
"Structure of the Palisades Intrusion at Haverstraw and West Nyack, New York" – Kurt E. Lowe, Department of Geology, The City College, New York, N. Y.

Session Chairman: Charles H. Behre, Jr.
Department of Geology, Columbia University, New York, N. Y.

"Study of the Metamorphic History of the New York City Area by Radioactive Age Methods" – Leon E. Long, Lamont Geological Observatory, Columbia University, Palisades, N. Y.

"Stratigraphic Position of the Lowerre Quartzite" – Matthew F. Norton, The American University, Washington, D. C.

"Field Relationships Bearing on the Age of the New York City Group of the Manhattan Prong" – John James Prucha, Shell Development Company, Houston, Texas.

Closing Remarks – Kurt E. Lowe, Department of Geology, The City College, New York, N. Y.

SECTION OF BIOLOGY

A DECADE OF ANTI-INFLAMMATORY STEROIDS, FROM CORTISONE TO DEXAMETHASONE

Monday, December 15 and
Tuesday, December 16, 1958

Conference Chairman: Joseph J. Bunim
Johns Hopkins University School of Medicine, Baltimore, Md.;
National Institute of Arthritis and Metabolic Diseases,
Public Health Service, Bethesda, Md.

MONDAY, DECEMBER 15, 1958

Session Chairman: Edward C. Kendall
Princeton University, Princeton, N. J.

9:00 A.M. –
Greetings from the Academy – Albert S. Gordon, Chairman, Section of Biology, The New York Academy of Sciences, New York, N. Y.; New York University, New York, N. Y.

Introductory Remarks – Edward C. Kendall, Princeton University, Princeton, N. J.

"Some Aspects of the Chemical Evolution of Anti-Inflammatory Steroids" – Lewis H. Sarett, Merck Sharp & Dohme Research Laboratories, Rahway, N. J.

"Synthesis of 16-Alpha and 16-Beta Methyl Corticoids" – Eugene Oliveto, Schering Corporation, Bloomfield, N. J.

"The Biology of Anti-Inflammatory Steroids" – Robert H. Silber, Merck Institute, Merck Sharp & Dohme Research Laboratories, Rahway, N. J.

"Laboratory Evaluation of Anti-Inflammatory Steroids" – Sibylle Tolksdorf, Schering Corporation, Bloomfield, N. J.

Session Chairman: Joseph J. Bunim
Johns Hopkins University School of Medicine, Baltimore, Md.;
National Institute of Arthritis and Metabolic Diseases,
Public Health Service, Bethesda, Md.

"Enzymes Involved in Metabolism of Corticosteroids" – Gordon M. Tomkins, National Institute of Arthritis and Metabolic Diseases, Public Health Service, Bethesda, Md.

"Metabolism of Adrenocortical Steroids in Man" – Ralph E. Peterson, Cornell University Medical College, New York, N. Y.

"Effects of Anti-Inflammatory Steroids on Electrolyte Metabolism" – Grant Liddle, Vanderbilt University School of Medicine, Nashville, Tenn.

"Effects of Anti-Inflammatory Steroids on Carbohydrate Metabolism" – Thomas F. Frawley, Albany Medical College and Albany Hospital, Albany, N. Y.

Session Chairman: Philip S. Hench
University of Minnesota (Mayo Foundation)
and Mayo Clinic, Rochester, Minn.

2:00 P.M. -
Introductory Remarks – Philip S. Hench, University of Minnesota (Mayo Foundation) and Mayo Clinic, Rochester, Minn.

"Treatment of Rheumatoid Arthritis with Adrenal Cortical Steroids and Their Synthetic Analogues: An Appraisal of Certain Developments"– Edward W. Boland, St. Vincent's Hospital, Los Angeles, Calif.

"Experience in Great Britain with Steroids in Rheumatoid Arthritis, Particularly Dexamethasone" – Oswald Savage, West London Hospital, London, England.

Discussion – Richard Freyberg, Cornell University Medical College and Hospital for Special Surgery, New York, N. Y.

"Ten-Year Survey of Hormone Management of the Allergic States" – Bram Rose, A. Knight, and E. McGarry, Royal Victoria Hospital and McGill University, Montreal, Canada.

"Treatment of Blood Dyscrasias with Anti-Inflammatory Steroids" – William Dameshek, Tufts University, Boston, Mass.

"Treatment of Eye Disorders with Anti-Inflammatory Steroids" – Irving Leopold, University of Pennsylvania Graduate School of Medicine and Wills Eye Hospital, Philadelphia, Pa.

"Therapeutic and Side Effects of the Anti-Inflammatory Steroids on the Gastrointestinal Tract"– Walter L. Palmer, University of Chicago School of Medicine, Chicago, Ill.

Summary – Joseph J. Bunim, Johns Hopkins University School of Medicine, Baltimore, Md. and National Institute of Arthritis and Metabolic Diseases, Public Health Service, Bethesda, Md.

TUESDAY, DECEMBER 16, 1958

Session Chairman: Russell L. Cecil
Cornell University Medical College, New York, N. Y.

9:00 A.M. –
Introductory Remarks – Russell L. Cecil, Cornell University Medical College, New York, N. Y.

"Treatment of Nephrosis with Anti-Inflammatory Steroids" – Conrad M. Riley, Columbia University and Presbyterian Hospital, New York, N. Y.

"Treatment of Emphysema and Cor Pulmonale with Anti-Inflammatory Steroids" – Alvan L. Barach, College of Physicians and Surgeons, Columbia University, New York, N. Y.

"Treatment of Childhood Allergies with Anti-Inflammatory Steroids" – Samuel C. Bukantz, Jewish National Home for Asthmatic Children and Children's Asthma Research Institute and Hospital, Denver, Colo.

"The Corticosteroids in the Management of Diseases of the Skin" – Victor H. Witten, New York University Postgraduate Medical School and New York University Hospital, New York, N. Y.

"Treatment of Childhood Dermatoses with Anti-Inflammatory Steroids" – Leon Goldman, University of Cincinnati School of Medicine, Cincinnati, Ohio.

"Treatment of Tuberculosis in Children Utilizing the Anti-Inflammatory Steroids" – Margaret H. D. Smith, New York University, New York, N. Y.

"Dexamethasone in Ophthalmalogical Disorders" – Daniel M. Gordon, Cornell University Medical College, New York, N. Y.

NEW MEMBERS

Elected December 18, 1958

LIFE MEMBERSHIP

Cohen, Lewis, M.D., Physical Medicine, Rehabilitation. Consultant, Private Practice, Huntington Woods, Mich.

Wiener, Morris Fred, M.D., Pathology. Director, Laboratory, Manhasset Medical Center Hospital, Manhasset, N. Y.

SUSTAINING MEMBERSHIP

Mamick, Stephen, M.D., Clinical Research. Chief, Radiology, Pathology, Williamson Memorial Hospital, Williamson, W. Va.

ACTIVE MEMBERSHIP

Avrin, Alexander, M.D., Medicine. Assistant Attending, Glens Falls Hospital, Glens Falls, N. Y.

Baird, Robert W., M.D., Internal Medicine, Endocrinology. Assistant Physician, Flower-Fifth Avenue Hospital, New York, N. Y.

Baker, Saul Phillip, M.D., Physiology, Assistant Professor, The Chicago Medical School, Chicago, Ill.

Barry, William Francis, Jr., M.D., Radiology. Associate Professor, Duke Hospital, Durham, N. C.

Bateson, Richard C., B.A., Radiation Safety Physics. Assistant to Radiation Safety Physicist, University of Pennsylvania, Philadelphia, Pa.

Benenati, Joseph A., M.D., Industrial Medicine. Medical Director, Grumman Aircraft Engineering Corporation, Bethpage, N. Y.

Benjamin, Helen R., Ph.D., Biochemistry. Lecturer, Physiology, Hunter College, New York, N. Y.

Berkowitz, Sidney Stephen, M.D., Rheumatology. Physician, Private Practice, New York, N. Y.

Bernard, Viola W., M.D., Psychiatry, Psychoanalysis. Associate Clinical Professor, Columbia University, New York, N. Y.

Black, Paul H., M.D., Internal Medicine, Infectious Disease. Clinical, Research Fellow, Massachusetts General Hospital, Boston, Mass.

Blum, Ludwig L., M.D., Anesthesiology. Staff, St. Claire's Hospital, New York, N. Y.

Brenson, Vera, M.A., Psychotherapy, Psychiatry. Psychotherapist, Private Practice, New York, N. Y.

Burwell, John T., Jr., Ph.D., Physics. Director, Research, American Radiator & Standard Sanitary Corporation, New York, N. Y.

Casselman, W. G. Bruce, M.D., Medical Research. Research Histochemist, New York State Psychiatric Institute, New York, N. Y.

Cayle, Theodore, Ph.D., Enzyme Chemistry. Biochemist, Wallerstein Company, Inc., Staten Island, N. Y.

Chenet, Paul C., M.D., Neoplastic Diseases. Chief Resident, Surgery, Harlem Hospital, New York, N. Y.

Cimino, James E., M.D., Pulmonary Physiology. Chief, Medical Service, 1360th U.S.A.F. Hospital, Orlando, Fla.

Conkright, William A., B.F.S., General Science. Head, Expansion & Development, The New York Academy of Sciences, New York, N. Y.

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Conrad, Agnes, M.D., Psychodynamics, Integration of Behavior. Psychiatrist, Private Practice, Washington, D. C.

Cosentino, Anthony J., M.D., Proctology. Physician, Surgeon, Private Practice, Staten Island, N. Y.

Daniels, James T., M.D., Neurological Surgery. Associate Clinical Professor, New York University-Bellevue Medical Center, New York, N. Y.

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Di Giorgio, John, Ph.D., Biochemistry. Research Associate, Children's Cancer Research Foundation, Boston, Mass.

Doczi, John, M.S., Biochemistry. Senior Research Associate, Warner-Lambert Research Institute, Morris Plains, N. J.

Drooz, Irma G., M.D., Psychiatry. Assistant Clinical Professor, New York State College of Medicine, New York, N. Y.

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Fastlich, Eugene, M.A., Chemistry. Chemist, New York Department of Health, New York, N. Y.

Feeney, George J., M.B.A., Operations Research. Research Consultant, General Electric Company, New York, N. Y.

Fischer, Joseph S., M.D., Psychoanalysis. Psychoanalyst, Private Practice, New York, N. Y.

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Goessel, Elizabeth A., M.A., Pharmacology. Research Associate, Human Pharmacology, New York, N. Y.

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Zirkle, Charles L., Ph.D., Medicinal Chemistry. Group Leader, Smith, Kline & French Laboratories, Philadelphia, Pa.

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